ESEARCH
UARTERLY

Vol. 31, No. 2,
Pt. 1
May 1960

1959 EDITION

RESEARCH METHODS in Health Physical Education Recreation

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RESEARCH
QUARTERLY

The Research Quarterly
of the American Association for Health,
Physical Education, and Recreation
A department of the National Education Association
1201 Sixteenth St., N.W., Washington 6, D. C.

VOL. 31, NO. 2, PT. I MAY 1960

CONTENTS

Published in March, May, October, and December by the American Association for Health, Physical Education, and Recreation (a department of the National Education Association), 1201 Sixteenth Street, N.W., Washington 6, D. C. Subscription available to libraries, institutions, and departments at $5.00 per year. *Subscriptions to individuals are available only through membership in AAHPER.* Of the membership ($15.00 per year), $4.00 covers subscription to the *Quarterly.* Of the student membership ($6.00 per year), $1.50 is for subscription to the *Quarterly.* Single copies $1.25. Send membership dues or subscription fees to AAHPER Circulation Department, 1201 Sixteenth Street, N.W., Washington 6, D. C.

Manuscripts are to be sent to the *Research Quarterly,* AAHPER, 1201 Sixteenth Street, N.W., Washington 6, D. C. Authors should follow the form prescribed in the "Guide to Authors" that appears each year in the October issue of the *Quarterly.*

Second class postage paid at Washington, D. C., and at additional mailing offices.

Objective Determination of Resistance Load for Ten Repetitions Maximun for Knee Flexion Exercise[1]

DAVID H. CLARKE
University of California
Berkeley, California
and
ROBERT N. IRVING
Sacramento County
Sacramento, California

Abstract

The number of repetitions subjects could perform when resistive weight for knee flexion exercise was equal to 40, 45, 50, and 55 percent of the strength of the flexor muscles of the knee joint was determined. A resistance load of 55 percent was found satisfactory for obtaining the desired ten repetitions maximum. When compared with available data for knee extension exercise, it was found that while both repetition decrement curves appeared linear, more repetitions were performed for knee flexion exercise at the lighter loads. In addition, more variability and greater strength increases during the exercise program were obtained for knee flexion exercise.

INTEREST IN AND the use of progressive resistance exercises as a means for increasing muscular strength seems well established. The emphasis given this process by DeLorme (4) and the subsequent use of his procedures in physical education and in various phases of rehabilitation have resulted in added stimulation for greater understanding of these methods.

In 1955, Clarke and Herman (1) studied knee extension exercises in order to determine the amount of weight that could be lifted ten times. Utilizing a cable-tensiometer to measure the maximum static strength of the quadriceps muscles, a group of subjects were given five knee extension exercise bouts based upon 30, 35, 40, 45, and 50 percent of this amount. Performing each bout by completely extending the weight as many times as possible, it was found that a value of 50 percent of the strength of the muscles tested was satisfactory for determining the ten repetitions maximum ($M = 10.43$, $\sigma = 2.32$). Thus, a practical method of quadriceps exercise administration seems possible, and the use of an objective test of muscular strength affords a means of measuring any increases that result from an exercise regime.

Inasmuch as it has been demonstrated that hamstring weakness accompanies quadriceps deterioration following injury (5), it would seem of importance

[1] From the Research Laboratory, School of Health and Physical Education, University of Oregon, Eugene, Oregon.

to give the knee flexor muscles equal consideration in any treatment procedure. A review of the literature suggests a need to expand the concept of objectively determining resistance loads for ten repetitions maximum, as no other research has investigated this procedure as applied to the knee flexor muscles.

Methodology

SUBJECTS AND TESTERS

The subjects utilized were 28 university students, the majority of whom were physical education majors or enrolled in activity classes. Prior to the collection of data the testers gained competence in the administration of the knee flexion strength test as part of their preparation for other research undertakings.

TESTING INSTRUMENTS AND TECHNIQUES

The testing instrument employed in this research was the cable-tensiometer, the same instrument used in the Clarke-Herman study.[2] Cable-tension tests were developed by Clarke (2) to measure the maximum static strength of many muscle groups of the body. In this study, his knee flexor strength test was used, with the single modification that the pulling strap was placed around the lower leg at the ankle joint. Only the right leg was utilized. The method of administering knee flexion exercise is described as follows:

1. The position of the subject's body was one of prone lying, head resting on folded arms.
2. A boot and calibrated iron weight plates were attached to a convalescent shoe which was placed over the foot of the subject (1).
3. No warm-up bouts were permitted; rather, the subject's exercise was confined to an alternate concentric and eccentric contraction of the flexors of the knee with the weight being raised each time past the vertical position created by the lower leg with the table.

EXPERIMENTAL PROCEDURES

The amount of resistive weight administered on each of four succeeding days was based upon certain percentages of the subject's strength as determined by an initial strength test. After some preliminary investigation, the percentages selected were 40, 45, 50, and 55. Also, in order to minimize the effects of a possible learning or an increase or decrease in strength of the muscles utilized in the exercise, the resistive bouts were systematically rotated. In this way, the subjects were divided into four subgroups and performed their exercise in the following order:

	40%	45%	50%	55%
Group 1 (N = 6)	1	2	3	4
Group 2 (N = 6)	2	3	4	1
Group 3 (N = 9)	3	4	1	2
Group 4 (N = 7)	4	1	2	3

[2] The writers are indebted to the University of Oregon for the loan of this instrument.

The subjects were instructed to continue this exercise for as many repetitions as possible, until they reached the point where they failed to raise the weight past the vertical position. On the day following the last bout, a strength test was administered to determine any changes in strength over the four exercise periods.

Results and Discussion

Mean repetitions for the right leg appear in graph form in Figure I. The values at each percentage were: 40 percent, 39.21 ($\sigma = 16.40$); 45 percent, 29.82 ($\sigma = 13.05$); 50 percent, 16.32 ($\sigma = 5.96$); and 55 percent, 11.07 ($\sigma = 4.34$). The repetition decrement appears to be linear, although some slight irregularities can be noted, particularly at the heavier work load of 50 percent of strength. Also, greater individual differences were apparent at the lighter work loads than at the heavier exercise sessions, as the standard deviation value at 40 percent was nearly four times that at 55 percent of maximum strength.

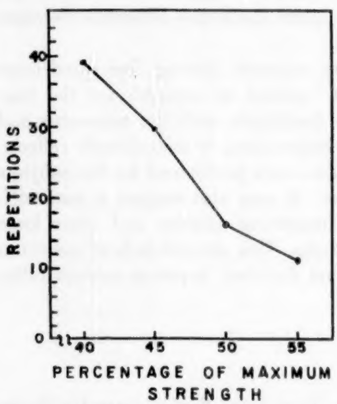

FIGURE I. — Mean repetition curve for knee flexion exercise at various percentages of strength.

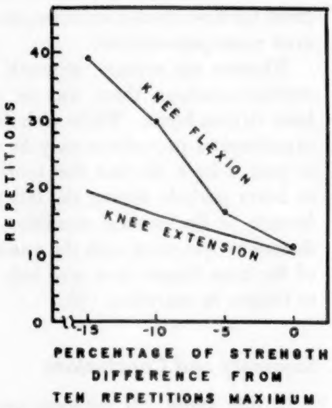

FIGURE II. — The relationship of repetition decrement for knee flexion and knee extension exercise at various percentages of strength.

The results of administering a strength test following the last resistive bout showed a mean strength increase of from 85.78 lbs. ($\sigma = 15.30$) to 96.82 lbs ($\sigma = 15.00$)—the difference of which is significant ($t = 5.52$).

Apparently, exercise loads apportioned as 55 percent of knee flexion strength best represented ten repetitions maximum. Although the mean number of repetitions at this level was slightly higher than ten ($11.07 \pm .83$),

nonetheless it is obvious that the difference is of no statistical significance, since it is barely larger than its own standard error.

COMPARISON WITH QUADRICEPS EXERCISE

Comparison of knee flexion with knee extension exercise (1) reveals certain differences. The two curves are plotted in Figure II with zero on the abscissa representing the point at which ten repetitions maximum is achieved. This is necessary, inasmuch as the ten repetitions are produced at different percentage of strength values in the two studies. In this manner, then, —15 represents the percentage of strength that is utilized in the performance of repetitions when the weight used is 15 percent less than that required to produce ten repetitions. It can be seen that quite wide differences exist between the two types of exercise, especially at the lighter loads. Although both are essentially linear, at a proportion of strength of —15, approximately twice as many repetitions were performed by the knee flexor muscles.

Much greater variability in the repetitions also was apparent throughout knee flexion as compared with quadriceps exercise. At the level of ten repetitions maximum, the standard deviation value was approximately twice as great for knee flexion exercise, and at the lighter loads this difference becomes even more pronounced.

Whereas no average strength increases occurred during five quadriceps exercise sessions, there was an apparent increase in strength for the four knee flexion bouts. While such factors as familiarity with the apparatus and experimental procedures may be of some importance, it undoubtedly reflects, in part at least, the fact that more repetitions were performed by the subjects in fewer periods during the latter exercise. It may also suggest a basic difference in the general condition of the hamstring muscles and other knee flexors as compared with the quadriceps group. This general lack of condition of the knee flexors may also help to account for their apparent susceptibility to fatigue in marching (3).

Summary and Conclusions

In this study, 28 subjects were given four knee flexion exercise bouts utilizing weights equal to 40, 45, 50, and 55 percent of the strength of the flexor muscles of the knee joint. Performing as many repetitions as possible at each exercise session, a resistance load equal to 55 percent of the strength of these muscles was found satisfactory for obtaining the desired ten repetitions maximum. However, the results of this study, as compared with those of knee extension exercise, show more variability during all phases of the exercise program. The findings of greater strength increases and differences in the linearity of repetition decrement for knee flexion exercise suggest some specificity of strength among the muscles surrounding the knee joint, a situation that may be made more acute when exercise is performed.

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(Submitted 8/6/59)

Effects of Selected Techniques on Recovery from Fatigue and Impairment in Athletes[1]

AIX B. HARRISON
Oklahoma State University
Stillwater, Oklahoma

Abstract

Four techniques were compared for effectiveness in promoting recovery during a ten-minute rest period between experimental work periods. The four techniques were: (a) lying supine, (b) elevation of arms and legs, (c) slow movement, and (d) watching sound movies. Two swimming subjects, two track subjects, and two treadmill subjects each completed 32 double work periods. Elevation of the arms and legs proved to be the most effective recovery technique for these subjects but it was not significantly superior. Slow movement during recovery resulted in significantly less oxygen debt being repaid in the treadmill subjects.

ATHLETIC COACHES and people doing sports research have long been interested in various techniques that might prove helpful in speeding recovery from fatigue and impairment in athletes. They have sought and are still searching for means of assuring better performance in second and third performances during the same day, or during the second half of late stages of a contest. Rapid recovery is especially important to those who participate in track or swimming events where they might be called upon to make two or more all-out efforts within a short span of time. It is also of considerable importance to team members of such sports as football, basketball, soccer, and hockey. Although many techniques have been tried and are currently being used throughout the world, none have been adequately proven through controlled research to actually give more effective recovery.

Review of Literature

Whiting and Bidwell (10) found no significant differences between mental and physical test scores obtained early in the morning and in the evening on the same subjects. This refuted the idea that people become fatigued through the day's activity. Charmichael and others (2) got similar results in working with young men that had been fatigued through lack of sleep. Their test results on range finding and hiking showed no decrement. A. T. Welford,

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[1] This study was made under the direction of Henry Montoye, Michigan State University, East Lansing, Michigan. Special gratitude is extended to Wayne Van Huss, Michigan State University, for his help in collecting the data and to Carl Marshall, Head of the Statistical Laboratory at Oklahoma State University, for advice on the statistical analysis.

editor of the *Symposium on Fatigue* points out (9) that many experiments have shown that the onset of fatigue is not accompanied by a decrement of activity. Browne (1) questions whether there is a single entity called fatigue. Lamb (5) found that a muscle was able to perform greater work after massage or application of radiant heat during recovery, than with plain rest. Jaraslav (4) found that massage could be an important regulatory activity during recovery after strenuous exercise. He found positive effects on blood PH, CO_2 output, alkali reserve, blood pressure, and pulse rate. McCurdy (7) found that the recovery processes of swimmers are more rapid if they stay in the water after a strenuous swim than if they are on the deck of the pool. Marschak (6) concluded that light active recuperation was more effective than passive recuperation between exercise bouts on the ergograph.

In 1937, Newman and his associates (8) completed a study on rate of lactic acid removal on three subjects during a recovery period following exhaustive treadmill runs. Removal of lactic acid from the tissues and blood stream has generally been accepted as a criterion of recovery from fatigue. They found that a subject that jogged slowly during the recovery period had a much faster rate of lactic acid removal than when lying in a resting state. The desire to further study the effectiveness of this recovery technique caused it to be selected as one of those to be studied in this investigation.

Another technique based on a similar theory was also chosen. This was elevation of arms and legs while resting in a supine position. According to Zankel and associates (11) this position resulted in the greatest aid to venous return to the heart of several techniques that they had tried, including massage, diathermy, bandaging, and various body positions. Theoretically, the heart can pump fresh blood to the tissues only as fast as venous blood is returned to the heart, so by increasing the rate of venous return one could logically expect to increase the amount of fresh blood going to the tissues and thus promote faster recovery.

Another recovery technique chosen for investigation was the watching of sound movies while resting. This technique is based on the theory that a nervous reorganization of the nervous system could promote recovery from the psychological experience of fatigue.[2] A fourth technique used in this study, that of simply lying in a supine position, was used as a control technique.

Purpose of the Study

The purpose of this study was to compare the relative effectiveness of four recovery techniques. The techniques studied were: (a) elevation of arms and legs while lying in a supine position; (b) slow movement (jogging for runners, slow swimming for swimmers); (c) watching sound movies; and (d)

[2] This concept was developed through study and consultation with S. H. Bartley, Psychology Department, Michigan State University, who is a recognized authority on fatigue.

lying in a supine position. The last technique was used as a control to offer a basis of comparison of the other techniques. The criteria for recovery from fatigue and impairment were performance time after recovery. In Part Two of the study, rate of recovery from oxygen debt was used as a criterion of recovery from impairment.

Definition of Terms

Fatigue. This is how one feels. It is a psychological experience of the human organism—a sort of negative attitude toward work.
Impairment. Any chemical change that takes place in the tissues. This includes oxygen deprivation and lactic acid accumulation.

Procedure

The data for this study were organized into two parts. The first part consisted of performance data collected on subjects at Oklahoma State University during the school year of 1957. Two subjects each made 32 repeat 200-yd. swims and two subjects each made 32 repeat one-half mile runs for this data. The recovery techniques were introduced in randomized block fashion during a ten-minute rest period between the runs or swims. These performance data were treated by use of the analysis of covariance technique which, in effect, equalized the first swim or run times for all 32 trials, then tested for differences in the second swim or run time according to the recovery technique being used.

The data for Part Two were collected at the research laboratory at Michigan State University during the summer of 1958. Two subjects each made 32 repeat runs on the treadmill. Each run consisted of a standard five-minute initial run, a ten-minute rest period, and then an all-out performance run to see how long the subject could remain on the treadmill. During the initial run the treadmill was started at six m.p.h. and no incline. The speed and incline of the treadmill were periodically increased during the initial run. Loud band music was played over an amplifying system during the initial run. The purpose of these things was to aid in inducing the psychological experience of fatigue by adding uncertain and distracting elements to the environment.

During the ten-minute recovery period the recovery techniques were introduced in randomized block order. For slow movement the subject stayed on the treadmill and jogged at 5 m.p.h. The movies used consisted of various travel, sports, and musical subjects, and were shown on the ceiling with the subject lying in a supine position so as not to vary the position from that of the other quiet techniques.

The all-out run was made with the treadmill going at 8 m.p.h. and at an incline of 10 deg. The subjects were instructed to stay on as long as possible. The performance data on the all-out treadmill runs were analyzed by using the analysis of variance to test for differences between the various recovery techniques.

Metabolic data were also collected for each subject during each experimental run of Part Two. This started with a five-minute collection of expired air while the subject was in a resting state. Expired air was also collected during the five-minute initial run and the recovery period. Gas collections for each period were metered for volume and sampled for oxygen and carbon dioxide analysis. The oxygen readings were made on a Beckman E-2 oxygen analyzer and the carbon dioxide readings were made with a Haldane Apparatus. From these figures the amount of oxygen debt repaid during each recovery period was computed. The oxygen debt repayment figures for each recovery technique were compared by analysis of variance.

Results

All subjects in Part One of the study reported that they felt more like starting out on a second swim or run if they had been moving during the recovery period. However, the results showed no improvement in performance on the second efforts after the slow movement technique had been used. On the contrary, in one subject participating in the one-half mile runs the slow movement technique resulted in significantly poorer times on the second runs. This was the only significant difference found in data of Part One.

The analysis of the all-out run times in the data of Part Two showed only one significant difference among the recovery techniques. This was in the elevation of the arms and legs which was significantly inferior at the 5 percent level to the other three techniques in one of the two subjects. The analysis of the oxygen debt figures for the treadmill runs showed that the slow jog technique resulted in significantly less (1% level) oxygen debt being repaid.

Tables 1 and 2 show the mean all-out run times for each recovery technique for the treadmill subjects of Part Two of this study. Tables 3 and 4 show the mean oxygen debt repayment after each of the four recovery techniques had been used on the two treadmill subjects. From Table 5 it can be seen that the technique of elevating the arms and legs resulted in the best recovery three times and second best three times for a better over-all record than any other technique. This indicates a trend for this technique to be consistently more effective, although not statistically so, than the other three techniques used in this study.

Conclusions

1. None of the techniques studied was significantly superior to the other techniques in terms of the criteria used in this study. On the basis of all the possible evaluations in this study there was a trend toward better results from the technique of lying supine with arms and legs elevated.

2. The slow jog or movement technique was found to give no better performance results than the control, and it was significantly inferior to all other techniques in terms of the amount of oxygen debt repaid during recovery.

TABLE 1.—MEAN ALL-OUT RUN TIMES OF SUBJECT A. F=3.18

Technique	elevation	control	slow jog	movies
run time sec.	218	235[a]	263[a]	269[a]

[a] Means are not significantly different from each other. For details of this testing technique see Duncan Multiple Range Test (3).

TABLE 2.—MEAN ALL-OUT RUN TIMES OF SUBJECT B. F=1.84

Technique	control	movies	elevation	slow jog
run time sec.	93[a]	99.57[a]	104[a]	104.22[a]

[a] These means indicate no significant difference between times.

TABLE 3.—MEAN OXYGEN DEBT REPAYMENT: SUBJECT A. F=32.98

Technique	slow jog	movies	control	elevation
Liters	.016	2.12[a]	3.69[a]	3.88[a]

[a] Means are not significantly different from each other at 1 percent level.

TABLE 4.—MEAN OXYGEN DEBT REPAYMENT: SUBJECT B. F=17.75

Technique	slow jog	elevation	movies	control
Liters	1.16	3.65[a]	3.80[a]	4.49[a]

[a] Means are not significantly different from each other at 1 percent level.

TABLE 5.—RANKINGS OF FOUR RECOVERY TECHNIQUES ON ALL SUBJECTS

Rank regardless of significance	Number of times each ranking was received			
	control	elevation	slow jog	movies
1	1	3	1	3
2	1	3	3	1
3	3	1	1	3
4	3	1	3	1

3. The watching of sound movies as a recovery technique does seem to offer some benefit, although the results from this study were inconclusive. The results from this technique varied from one subject to another and according to the types of movies shown. This technique needs further and more detailed study.

4. There was no relationship between the oxygen debt repayment figures and the subsequent treadmill performance in the subjects of this study. This raises the question of whether the accumulation of oxygen debt or other forms of impairment are good criteria of fatigue, or whether the repayment of oxygen debt is a good criterion for recovery from fatigue.

5. This study could not effectively measure recovery from the psychological experience of fatigue (as different from impairment) because there was not a sufficient measure available of the level of fatigue reached by each subject.

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(Submitted 11/19/59)

Effect of Posthypnotic Suggestions on All-Out Effort of Short Duration[1]

WARREN R. JOHNSON
BENJAMIN H. MASSEY
GEORGE F. KRAMER
University of Maryland
College Park, Maryland

Abstract

Ten young men in excellent physical condition were trained to meet specified criteria of hypnotic trance depth (including complete posthypnotic amnesia) and were tested twice on all-out rides of 100 revolutions on the bicycle ergometer (26.3 lb. resistance.) The subjects were placed in a trance before both test rides, but before only one test they were given posthypnotic suggestions, which were not recalled consciously, that they would have unusual strength, endurance, and freedom from fatigue and would recover rapidly after the exertion. The mean advantage of the ride following posthypnotic suggestions was not statistically significant, but the subjective reports of the subjects were favorable to the suggestions.

REVIEWS BY GORTON (3) and Crasilneck and Hall (2) dealing with the physiology of hypnosis include brief discussions of hypnosis in relation to muscular exertion. More recent discussions by Cofer and Johnson (1) and by Johnson (4) include further information that is concerned specifically with gross motor performance. In brief, most experimental reports of motor performance are favorable to hynotic and posthypnotic suggestions. In some instances, the advantage to hypnotic and/or posthypnotic performance was found to be highly significant statistically. The tests utilized have for the most part involved small muscle responses, such as speed of tapping with a pencil or stylus and steadiness tests. The studies by Mead and Roush (5) and by Roush (6) were especially relevant to the present research because they included some gross motor testing (grip and arm muscle strength and endurance). Roush found that by employing rigorous controls, a very deep trance, and suggestions to disregard pain and fatigue, statistically significant improvements resulted in all tests.

The present research was undertaken to study the effect of posthypnotic suggestions upon maximum short duration effort involving gross bodily and severe circulatory response.

[1] Appreciation is expressed to Lester M. Dyke, M.D., director of student health services, University of Maryland, and to Harold Rosen, M.D., Ph.D., of Baltimore, for consultation and advice on certain aspects of this research.

Procedures

Ten athletes and/or physical education major students in good physical condition were trained to enter a relatively deep trance when asked to do so. These subjects were selected from among approximately 45 volunteers on the basis of their ability to learn to enter a trance quickly in response to a signal, and to meet the criteria of trance depth established for the study. The following minimum criteria for depth of trance were used:

1. Invariable and complete posthypnotic amnesia; i.e., after being aroused from a trance, the subject had no conscious recollection of what had occurred or was said during the trance.
2. Ability to talk and to move about as directed in a skillful and entirely natural manner while in the trance state.
3. Ability to experience the onset intensification, and removal of pain and fatigue symptoms (headaches, muscular pain, general feelings of fatigue) as suggested in the trance state.
4. Ability to carry out posthypnotic suggestions of a sensory and motor kind, such as itchiness of the skin, uncontrollable eyelid blinking, smarting of the eyes, feelings of severe fatigue, and exceptional feelings of well-being and alertness.

A bicycle ergometer equipped with automatic counter and set for 15 lb. resistance was utilized in the study. The seat height was adjusted for each individual; gymnasium-type shoes, tee shirt, and shorts were worn for each ride; and the laboratory temperature was maintained at 73 to 75 deg. throughout the study. All subjects took two practice rides several days prior to testing.

The subjects took two test rides on days that were not consecutive. Before both tests, the subjects were hypnotized; but before only one test were posthypnotic suggestions given for exceptional performance. Both hypnotic sessions were followed by amnesia concerning what had occurred during the trance. Every other subject received the suggestions before the first ride and the other half received them before the second.

Prior to each test, the subject was seated in a quiet room near the laboratory. He was hypnotised and told that when he had reached the proper depth of trance (as set by the criteria), one of his hands would rise spontaneously to his face as an indication of his readiness. (This procedure had been carefully practiced and never failed to serve as a convenient signal of readiness. The hand usually reached the face in one or two minutes.) Before one of his two tests, suggestions were then given to him twice over a period of about 10 min.

The hypnotized subject was then asked, while still in a trance, to open his eyes. He was then told to rise and walk into the laboratory where he was seated, closed his eyes, and was given approximately the same suggestions twice more. He was then aroused from the trance in a manner that had been routinely adopted in preparation for the experiment, removed his outer clothing (sweat clothing), and mounted the bicycle. Four minutes elapsed from the time the subject was seated on the chair until he was seated on the bicycle.

After mounting the bicycle, the subject was given standardized instructions to make an all-out effort for 100 revolutions (all agreed not to try to pace themselves), to remain seated, and not to stop pedaling until instructed to do so. During the ride, he was quietly encouraged and each 25 revolutions was called out. The same procedures were followed in relation to the subject's other ride except for the omission of the posthypnotic suggestions.

All suggestions were given in a deliberate, quiet, but authoritative manner. They were not fully standardized, but were to the effect that the subject's legs would feel and be especially strong, his endurance would be especially good, fatigue would not set in as soon as usual or be as severe or painful, and he would make an extraordinarily good ride. He was also told that he would recover quickly and feel good after the ride. The individual subject's name was used periodically to personalize the suggestions.

Results

The findings of the study do not support the hypothesis that urging a subject while in a deep trance materially improves posthypnotic performance. The mean performance following the posthypnotic suggestions was 39.66 sec. and after no suggestions 39.90 sec. The difference between these two means was not statistically significant at the .05 level as indicated by a t-ratio of .85 using the paired score difference method. The consistency of performance under the two experimental conditions was quite good; the coefficient of correlation was .94. Six of the ten subjects had faster times after hypnotic urging than after the control condition. The mean improvement for the six was .88 sec. Four of the subjects performed worse after the hypnotic suggestions, with a mean increase in time of .72 sec. Of the six subjects showing an improvement in performance with suggestions, four performed the ride as the second test and two performed the ride as the first test. Of the four subjects showing slower times, two performed the ride after the suggestions as the first test and two as the second test.

TABLE 1.—PERFORMANCE ON BICYCLE ERGOMETER (100 REVOLUTIONS)

Case	Without Suggestions			With Suggestions			Difference
	Test	Date	Time	Test	Date	Time	
1	II	10/25/57	40.8	I	10/24/57	41.2	—0.4
2	I	10/28/57	40.9	II	10/30/57	39.4	—1.5
3	I	10/30/57	38.9	II	11/ 1/57	38.4	+0.5
4	I	11/ 4/57	35.5	II	11/17/57	34.9	+0.6
5	I	11/12/57	40.0	II	11/17/57	41.1	—1.1
6	II	11/27/57	42.6	I	11/23/57	41.9	+0.7
7	I	12/02/57	35.8	II	12/11/57	36.5	—0.7
8	II	12/14/57	42.7	I	12/ 3/57	41.6	+1.1
9	I	1/29/58	42.4	II	1/30/58	41.5	+0.9
10	II	3/ 4/58	39.4	I	2/24/58	40.1	—0.7
			X=39.90			X=39.66	

Bicycle ergometer performance is markedly affected by practice, with the result that continual improvement tends to take place over a number of repeated trials. Although the two rides in this experiment were accomplished after four previous time trials had been executed, it was thought that slight improvement in riding performance following suggestions might, in part, be related to the sequence of testing. As a matter of interest, the coefficient of correlation between tests I and II was computed and the significance of the mean difference evaluated in terms of the t-ratio based on the paired difference method of computation. The coefficient of correlation was .93. The mean riding time of the ten subjects on the second test was 39.72 seconds as opposed to 39.84 seconds, making a decrease in time (or improvement) in performance of .12 seconds. This difference was in the direction favorable to suggestions since four of the six subjects showing improvement in performance after hypnotic suggestions had performed the postsuggestion test as the second ride. However, the mean improvement in time of .12 seconds was not statistically significant, as shown by a t-ratio of .41.

The subjective reports of the subjects regarding their condition following the tests were consistently more favorable following the ride when suggestions were given. That is, subjectively, they seemed to respond to the hypnotic suggestions concerned with feeling less fatigued, feeling better, and recovering more rapidly after the ride.

Discussion

The findings in this study are not necessarily at odds with previously reported studies in which hypnotic and/or posthypnotic suggestions gave rise to improved performance. Uniquely, the present work involved (a) subjects with relatively quite high physical fitness and (b) an all-out exertion involving maximum gross body effort with associated circulatory and respiratory response.

It is entirely possible that the sports experience of these subjects had already accustomed them, more or less, to the discomfort of acute fatigue symptoms—with the result that posthypnotic suggestions to ignore such discomfort might not be as effective with them as with nonathlete subjects (such as were presumably involved in previous studies in which results were favorable to hypnosis). Moreover, the exercise, demanding as it was, did not require prolonged exposure to severe fatigue symptoms and may therefore have been within the tolerance range of the subjects in this study.

Summary and Conclusions

Ten subjects in good physical condition were trained to enter a deep hypnotic trance quickly at a signal. Minimum criteria for depth of trance were posthypnotic amnesia, ability to move about skillfully and naturally as directed while in a trance, and the ability to carry out various relatively complicated hypnotic and posthypnotic suggestions having to do with sensory and motor responses.

The subjects were tested twice to determine how long it took them to pedal the bicycle ergometer (26.8 lb. resistance) 100 revolutions. Procedures prior to testing were standardized, including entering a hypnotic trance for about 13 minutes before both tests, with the exception that before only one of the two tests posthypnotic suggestions were given four times. The suggestions had to do with improved strength and endurance, decreased sensitivity to pain, and rapid recovery after the exertion.

The mean performance after suggestions did not differ sufficiently from the mean performance after no suggestions to warrant the claim that either performance was superior. Subjective reactions of the subjects as to how they felt after their rides were consistently more favorable when hypnotic suggestions were given, even though the subjects were not consciously aware that suggestions had been given.

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(Submitted 11/16/59)

Interrelationships among Reaction Times and Speeds of Movement in Different Limbs[1]

WILLARD S. LOTTER
University of California
Davis, California

Abstract

Two movements basic to sports skills, a modified baseball throw and a football kick, were studied in 105 college men. Individual differences in ability to move an arm or leg quickly were found to be uncorrelated with the reaction time for these movements. There was only a moderately high correlation between the reaction ability of the right and left legs, and between the right and left arms. Arm vs. leg correlations were significant but low. A similar pattern of correlations between limbs was found for movement ability, but all correlations were considerably lower and movement specificity was high. The reliability of individual differences was high in all of the measures.

THE ABILITY to move the body or its limbs quickly is a complex function, involving neuromotor latency as well as the net motor component of the movement. The question of the degree of relationship between individual differences in the speed of reaction (latency between signal and start of movement) and the actual speed of movement of a limb (timed from start of movement to its end) was implicitly raised by Rarick in 1937 (11). This question was again raised by Henry in 1951 (2), and was followed by a study in 1952 (3) in which the correlations in two experiments were found to be approximately zero between the net speed of an arm movement (MT) and its reaction time (RT). One of these experiments employed a terminated movement (treadle press, n = 43) and the other a nonterminated movement (ball snatch, n = 60). The same year, Slater-Hammel (13) confirmed these results, using a horizontal arm swing (n = 25). He emphasized the importance of using nonterminated movements in studying MT.[2]

Later investigations have yielded somewhat variable results, Fairclough (1) found a nonsignificant correlation of —.28 between RT and MT (n = 40), and Howell (8) found a significant negative correlation of —.38 in a situation involving special motivation (n = 50). Pierson (9) observed a

[1] From the Research Laboratory of the Department of Physical Education, Berkeley Campus of the University. The writer is indebted to that department for furnishing equipment and facilities for the study.

[2] Henry (personal communication) has expressed concern to the writer that he and Slater-Hammel are considered to have placed different interpretations on a correlation of zero. He has corresponded with Slater-Hammel and found that there is no intent to differ in interpretation.

correlation of zero (n = 50). Hipple (7) found a positive correlation of .31, low but significant (n = 60), and Wilson (14) has recently reported a significant positive correlation of .31 (n = 50). In a later and more extensive study of 400 subjects ranging in age from 8 to 83 years, Pierson (10) reported an average correlation of .56. When "allowances for the effects of age were made," the correlation dropped to .31 (statistically significant). His college group (40 subjects having an age range of 19-25 yrs.) exhibited a correlation of .35. He also reports the correlations within successive age groups of 20 subjects. In the group designated 20 yrs. the correlation was zero, while in the next age group designated 22½ yrs. it was .55 (note that a correlation of .44 would be significant at the 5 percent level). Thus there was great irregularity of results within the college age group. For the younger ages there was also considerable irregularity in the relationship. For those groups designated as 8, 9, 13, and 14 yrs., the correlation was .20 or less; for age groups 10, 12, and 15, it was .40 to .50, while at age 16 it was negative .35. There was also a large degree of irregularity in the results for subjects in the older middle ages; for example the correlation was .27 for age group 37 yrs., while the next age group (42 yrs.) showed a correlation of .82.[3]

Recently there has been considerable interest in the structure of motor abilities from the individual difference point of view. While a high degree of task-specificity has been recognized (4), there has been little or no investigation of the degree of bilateral generality of large muscle motor coordination abilities.

Problem Investigated

In view of the apparent variability in the direction and amount of correlation between RT and MT, it does not seem safe to attempt generalization at the present time. The experiments reported above have been concerned with movements that were convenient for laboratory testing; they were not (except for the ball snatch) selected primarily because of their importance in athletic activities. For this reason, the writer has chosen to investigate two movements, one involving the arm and the other the leg, that are related to certain fundamental sports skills. They will be explained in detail under Methodology.

It has also seemed desirable to broaden the scope of the problem. Motor coordination is a complex thing. It may be assumed that individual differences in speed of movement are to a considerable extent dependent on neuromotor coordination abilities (4). Evidently nothing is known concerning the correlation between speed of movement ability as exhibited by the two arms

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[3] Since this review was written, results of another study have become available. In college women, Youngen (15) finds a correlation between RT and MT of .27 in 47 athletes and .25 in 75 nonathletes. The first of these is just below statistical significance at the 5 percent level; the second is just above the critical value for that level.

(or the two legs) considered separately, or as between the arms and the legs. Such information is important in evaluating and extending current theory on the specificity or generality of motor coordination abilities (4, 5). Additional information on the correlation between individual differences in speed of reaction as exhibited in the different limbs is needed. Some research is already available on the latter problem (12) although there is apparently no information regarding the correlation between the limbs that would be linked together in movements of progression, e.g., left leg vs. right arm. The present study reports data intended to answer these questions, or provide the needed information.

Methodology

Reaction Time and Chronoscope Circuit. For both kinds of movement, there was a warning light and then a foreperiod interval which was randomly varied from one to four seconds, followed by the stimulus signal (a neon light). The control key was of the three-position silent type. Turning on the stimulus automatically started the RT chronoscope. When the hand (or foot) left the reaction key, the RT chronoscope stopped and the MT chronoscope started. After the hand (or foot) had travelled the specified distance (28 in.) it hit a string and passed on, causing the dislodgement of a small plastic strip which held the movement key closed. When the strip dropped out, the key opened, thus stopping the MT chronoscope. The details of the circuit, and the accuracy of the equipment, have been described in a recent article by Henry (6). Chronoscopes were read to .001 sec., i.e., interpolated to tenth-divisions of the scale, which was marked in hundredths of seconds.

Arm Movement. The starting arm position was similar to that taken when raising the hand to throw a ball. From a standing position, the subject placed the middle knuckle of his index finger against the reaction key which was in a position laterally outward 12 in. from and 12 in. above the point of his shoulder. At the flash of the stimulus light, he moved his hand with a downward nonterminated stroke to hit a tennis ball suspended at chest level directly in front of the striking hand. The distance the hand moved was 28 in. The stimulus light was placed so that the subject could see both it and the ball at the same time. He was instructed to swing as fast as possible, making a complete follow-through, and not worry about missing the ball. When the ball was hit, the upper plastic strip that held the supporting string dropped free, activating the movement key. The ball was caught by a hanging towel to prevent rebound. The apparatus was similar to that used by Wilson (14), except that it was arranged for movement in the vertical plane.

Leg Movement. The starting leg position was similar to that assumed when kicking a field goal in football. The subject stood with his kicking foot on a small platform that inclined from the floor at an angle of nine deg. His heel was pressed against a reaction key mounted on the back end of the platform. The weight-bearing foot was 12 in. ahead of the kicking foot. At the signal,

he kicked vigorously forward to strike a target (12 in × 12 in.) hinged to the floor, and placed 28 in. ahead of the kicking toe. The target was made of ½ in. foam plastic. A string was stretched laterally behind it, with the free end fastened to the pull-out strip. With this arrangement, touching the target with the toe caused the movement timer to stop. (It had started automatically when the subject moved his foot away from the reaction key.) Emphasis was placed on making a complete follow-through as in kicking a football.

Subjects. Two groups of adult males were tested. One consisted of 80 college students, with a mean age of 20.0 years ($\sigma = 1.3$); the other group consisted of 25 graduate students and staff members; the mean age was 24.7 yrs. ($\sigma = 5.9$). All were volunteers. No particular systematic method of selection was used.

Procedure. Each subject followed the same pattern of testing, with the right arm, left arm, right leg, and left leg being tested in that order. There were 25 trials for each of the four movements. Because it was found that it took four or five trials for the subjects to become familiar with the testing procedure and apparatus, only the last 20 trials were used in the statistical analysis. All testing of each subject was done in a single one-hour period.

Results

Time Differences between Limbs. The data in Table 1 show that MT for the right arm is 3.2 percent faster than for the left (t = 2.3), and MT for the right leg is 3.2 percent faster than for the left (t = 4.8). The arm is 28.7 percent faster than the leg on the right side (t = 20.6) and also 28.7 percent faster on the left side (t = 23.4). (The distance moved, 28 in., was the same for arms and legs.)

TABLE 1.—DESCRIPTIVE STATISTICS AND UNCORRECTED RELIABILITY COEFFICIENTS FOR REACTION AND MOVEMENT TIMES

		Movement Time				Reaction Time			
	Statistic	R. Arm	L. Arm	R. Leg	L. Leg	R. Arm	L. Arm	R. Leg	L. Leg
Group 1	M (sec.)	.124	.129	.161	.167	.238	.242	.277	.274
n = 80	σ	.015	.016	.011	.011	.027	.032	.035	.030
	r	.950	.930	.961	.963	.837	.899	.919	.921
Group 2	M (sec.)	.131	.129	.162	.162	.228	.224	.258	.265
n = 25	σ	.021	.017	.012	.011	.026	.028	.030	.028
	r	.968	.942	.894	.735	.829	.880	.934	.913
Total Group	M (sec.)	.125	.129	.161	.166	.236	.238	.273	.272
n = 105	σ	.017	.016	.011	.011	.026	.032	.034	.036
	r	.957	.932	.946	.905	.841	.902	.923	.918

In the case of RT, the two arms do not differ significantly (t = 1.1); neither do the two legs (t = 0.4). The right arm reacts 15.7 percent faster than the right leg (t = 11.9) and the left arm reacts 14.3 percent faster than the corresponding leg (t = 10.3).

Reliability of Individual Differences. The reliability coefficients have been computed as the correlation (r) between the first and second halves of the 20-trial test. The mean RT's for the halves do not differ significantly for any movement or limb in either group of subjects; the t-ratios range from 0.08 to 1.88. In the case of MT, seven of the eight t-ratios are nonsignificant, ranging from 0.40 to 1.55. The second half of the test for left-arm movement time in the group of 25 subjects is 2.2 percent faster than the first half, which is statistically significant at the 5 percent level ($t = 2.26$). However, when the two groups are combined making a total of 105 subjects, the t-ratio for the difference between the two halves is only 1.80 which is not significant. The two halves of the test therefore seem to be comparable. The uncorrected (half-length test) reliability coefficients for the two groups and for the total group ($n = 105$) are given in Table 1. It can be seen that all of these reliability coefficients are fairly high. The lowest in the case of RT is .829 for the right arm in the smaller group. Corrected by the Spearman-Brown method, this becomes .906. For MT, all of the reliabilities are above .930 in the larger group. One of them (left leg) is relatively low in the smaller group, namely .735. This becomes .847 when corrected by the Spearman-Brown method.

Correlations between Reaction and Movement Times. These correlations are presented in Table 2. It may be seen that there is a tendency for a low

TABLE 2.—CORRELATIONS BETWEEN REACTION TIME AND MOVEMENT TIME

	Raw Correlation				Corrected Correlation			
	R. Arm	L. Arm	R. Leg	L. Leg	R. Arm	L. Arm	R. Leg	L. Leg
Group 1	—.119	—.211	.002	—.144	—.133	—.221	.002	—.148
Group 2	—.321	.088	—.329	—.252	—.340	.093	—.345	—.280
Total Group	—.208[a]	—.136	—.082	—.133	—.232[a]	—.148	—.087	—.146

[a] Significant at the 5 percent level.

negative correlation. This tendency is erratic; for example it appears chiefly in the left arm in the first group of subjects, and in the other three limbs but not in the left arm in the second group of subjects. In the total group ($n = 105$), it might be claimed that the correlation is significantly different from zero in the case of the right arm, but not for the other limbs. The average of the four corrected correlations is —.153, which is nonsignificant. There is very thin evidence for the existence of other than a zero correlation between RT and MT in these data.

Movement Time Correlations between Limbs. The upper part of Table 3 shows that the correlation between the two arms, and also between the two legs, is relatively high. There is a low positive correlation between the arm and leg on the same side of the body; it is somewhat higher on the left side. The right leg shows about the same correlation with either arm; the correlation between right arm and left leg is of questionable significance.

TABLE 3.—INTRA-LIMB CORRELATIONS

	Movement Time				Reaction Time			
	n=80	n=25	n=105	n=105 (corrected)	n=80	n=25	n=105	n=105 (corrected)
Right arm *vs.* left arm	.527[a]	.739[a]	.581[a]	.598[a]	.768[a]	.656[a]	.750[a]	.807[a]
Right leg *vs.* left leg	.683[a]	.607[a]	.639[a]	.665[a]	.876[a]	.494[a]	.837[a]	.837[a]
Right arm *vs.* right leg	.287[a]	.122	.241[a]	.247[a]	.521[a]	.358	.502[a]	.537[a]
Left arm *vs.* left leg	.371[a]	.354	.361[a]	.371[a]	.603[a]	.146	.534[a]	.561[a]
Left arm *vs.* right leg	.228[a]	.226	.229[a]	.236[a]	.654[a]	.175	.589[a]	.618[a]
Right arm *vs.* left leg	.303[a]	.061	.180	.187	.445[a]	.307	.362[a]	.388[a]

[a] Significant at the 5 percent level.

Reaction Time Correlations between Limbs. These coefficients are also given in Table 3. They follow the same general pattern as for MT, although they are considerably larger. In both RT and MT the two legs exhibit a larger correlation than the two arms, the arm-leg correlation is somewhat higher on the left side of the body than on the right, and the left arm—right leg correlation is higher than the right arm—left leg correlation.

Discussion

For the movements and subjects investigated in this study, it is clear that the results agree with Henry, Slater-Hammel, Fairclough, and Pierson's first experiment, with respect to almost complete independence of the abilities to react quickly and to move rapidly. If there is any correlation in the present data, and that is questionable, it is in the negative direction.

The results tend to disagree with those reported by Hipple, Wilson, and Pierson in his second study. It is doubtful if the disagreement can be ascribed to a difference in the age factor. Pierson's age groups designated 22 yrs. and 27 yrs. showed positive correlations of r = .55 and .46, while the smaller group of the present study, of approximately age 25, showed a correlation of —.32 between RT and MT of the right arm and ranging from .09 to —.33 for the other limbs. His 20 yr. age group showed a correlation of zero, which agrees with the larger group of the present study, where the correlation for the right arm was —.09, and none of the other limbs show a significant RT-MT relationship. It also seems unlikely that the disagreement hinges on the issue of "terminated" vs. "nonterminated" movement. Hipple and Wilson agree in finding a positive correlation of .31 between RT and MT; the former used a terminated movement (treadle press) while the latter used a nonterminated horizontal arm swing. It likewise appears unlikely that the complexity of the movement in the different experiments, or the type of RT stimulus, could be responsible. Howell's experiment used special motivation con-

ditions (automatic severe electric shock on slow responses) and yielded a considerable negative correlation, namely —.37. This suggests that there may have been some other unidentified conditions in the methods used in certain of the other studies that are responsible for the occurrence of a low positive correlation.

The results show a high degree of specificity for movement time abilities of the upper vs. the lower limbs. While the correlations are statistically different from zero, they are quite low, r = .25 and .37 for the right side and left side respectively. These figures mean that the percent of individual difference variance that measures the amount of generality of abilities ($r^2 \times 100$) is only 6 and 14 percent for the right and left sides, compared with 94 and 86 percent specificity (the latter being $k^2 \times 100$ in the case of correlations that have been corrected for attenuation). There is a greater amount of generality as between the two arms (36%) and as between the legs (44%), but even here the specificity of movement ability (64% and 56%) is considerably greater than the generality.

In the case of reaction time, there is considerable generality of ability as between the two legs (76%) and as between the two arms (65%), but not much between the arms and legs (29% for the right side and 31% for the left). It was anticipated that the correlations between the left leg and right arm would be higher than between the leg and arm on the same side of the body, because these limbs are linked in movements of progression. This hypothesis is not supported by either the RT or MT data.

It is interesting that arm-movement RT's to a visual stimulus reported in the other studies show little or no difference, ranging from .19 to .22 sec. (The RT's in Hipple's study are of course not comparable because he used boys age 12-14 as subjects rather than college-age men). The mean RT in the present study is almost .24 sec., and is significantly larger than the slowest of the other studies (t = 2.76). It is possible that the starting position of the hand, usually placed at table height in front of the subject, was more favorable for quick reaction in the other experiments. In the present study the hand was held in a partially flexed position above the shoulder. In the case of RT for a leg movement (.27 sec.), the present results agree almost exactly with the only other experiment that is at all comparable (Fairclough, .27 sec.).

Summary and Conclusions

Speed of arm and leg movements and the reaction time for these movements were measured for a modified baseball throw and a football kick. Data were obtained for both arms and both legs in 105 college men. The average time required to move the arm 28 in. in the baseball throw was .13 sec. for the right and 3 percent longer for the left. The time required for moving each of the legs the same distance (28 in.) was 29 percent greater, with the left leg 3 percent slower than the right. All of the differences were statistically significant. The average RT for the arms was .24 sec. and for the legs .27 sec., with

no significant difference between right and left for either. The 15 percent slower reaction of the legs was a statistically significant difference.

Individual differences in all of the measures yielded half-test reliability coefficients above .90 except right arm RT, which was only .84, but became .91 when corrected to full test length. For three of the four limb movements there was no significant correlation between RT and MT abilities; in the exception (right arm) the correlation was —.21, which became —.23 after correlation for attenuation in both variables, and was significant at the 5 percent level. Correlations between RT for contralateral limbs (corrected) were .80 (arms) and .87 (legs); between limbs on the same side of the body, .54 (right) and .56 (left); between upper and lower limbs, .62 (left arm vs. right leg) and .39 (right arm vs. left leg). In the case of MT, the corresponding correlations were lower: .60 between arms and .67 between legs; .25 between right arm and leg and .37 between left arm and leg; .24 between left arm and right leg, and nonsignificant between right arm and left leg.

On the basis of the factual data, it is concluded that for subjects and movements of the type investigated, leg movements are slower and have a longer reaction time than arm movements. There is more specificity and less generality of individual differences in movement time than in reaction time, and more specificity between arms and legs than between the two arms or the two legs. There is more specificity between diagonally paired arms and legs than between arms and legs on the same side of the body. Quickness of reaction and quickness of movement are distinctly different and unrelated abilities. Individual differences in the movements studied are specific to the limbs used in the movement and do not represent a general ability that characterizes the individual.

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(Submitted 7/16/59)

Reaction Time, Movement Time, and Task Specificity Relationships at Ages 12, 22, and 48 Years[1]

STEPHEN MENDRYK
University of Alberta
Edmonton, Alberta, Canada

Abstract

Reaction time and movement time in 150 subjects divided into three age groups showed an average intercorrelation of only .127 for a short arm movement and .138 in a longer movement. The correlation was nonsignificant and unrelated to age, although the absolute speeds of RT and MT were both approximately 12 percent faster in college men age 22 than in 12-year-old boys or 48 year-old men. Individual differences exhibited 74 percent task specificity for short vs. long movement, compared with only 26 percent general ability to move the arm quickly. There was also more task specificity than general quickness ability in speed of reaction.

WHILE RESEARCH WORKERS in our field have frequently investigated quickness of reaction and movement, the earlier studies (1931 to 1952) measured only the elapsed time between a starting signal and the completion of some specified movement. This time included a variable combination of reaction time and net movement time (1, 3, 4). The necessity for separating these two phases of the neuromotor response has since become evident. The evidence, as reviewed by others (5), has indicated that individual differences in RT and MT are frequently independent and uncorrelated in a variety of motor performances, although a low but statistically significant relationship is sometimes found (6).

A recent study by Pierson (5) has thrown doubt on the generality of this very low correlation. Testing 400 individuals stratified into 20 age groups of 20 individuals each, he reported a RT-MT correlation of .45 for age 10, .37 for age 11, and .50 for age 12. For the 40 subjects of college age (19-25 years) the correlation was .35. In the older subjects, he found a correlation of .82 for the 40-45-year-old group and .86 for the 45-55-year-old group. Certain other age groups showed low correlation, e.g., zero for the 20-year-old group. The correlation for the 400 subjects, with the influence of age removed, was .33.

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[1] This report is from the Research Laboratory of the Department of Physical Education, University of California. Acknowledgment is made to Franklin Henry for advice and encouragement during the course of the investigation.

Problem Investigated

Considering the above results, it seemed desirable to reinvestigate the relationship between RT and MT for the 11-in. forward arm-thrust movement employed by Pierson, using the age ranges 10-13 years and 40-55 years (where his correlations were particularly high), as well as the range 19-25 years (where they were particularly low). It was thought necessary to test a larger number of subjects in each of these age ranges, and to determine the reliability coefficients for RT and MT to ensure that low intercorrelations (if obtained) would not be caused by low reliability.

It was decided to broaden the problem by including another movement. As a result of preliminary experimentation, the performance chosen was a 25-in. circular clockwise orbit of the hand in the horizontal plane, with continuation of the movement on a tangent in the forward direction for a total distance of 36 in. This movement was standardized as will be explained below.

Methodology

Apparatus. The reaction board was a horizontal panel 7½ x 13 in. At the near end, the subject's reaction key was mounted flush. At the far end, a lightweight celluloid target 2 x 3 x .035 in. was hinged athwart the panel, so as to project vertically when in the ready position. A warning light and a signal light (miniature neon glow lamps) were supported by semiflexible wires in a convenient position that was slightly behind and to the left of the target, and about 3 in. above it.

In the starting position, the subject's index finger rested lightly on the reaction key (microswitch #1). The experimenter moved a three-position silent lever switch (shielded from view) to the ready position, which turned on the warning light. After a lapse of from 1 to 4 sec. (in chance order, to prevent reactions to the warning signal) he moved the switch to the stimulus position. This turned on the stimulus light and the RT chronoscope. The subject responded by moving his hand forward 11 in. as rapidly as possible, striking the target with his finger tips and continuing the movement with as much follow-through as he desired. Removal of his hand from the reaction key at the start of the movement stopped the RT chronoscope and started the MT chronoscope; the latter was stopped by touching the target. Since the target was light and easy to move, the slightest touch of the finger tip against it was sufficient to cause it to turn to the horizontal position flush with the main panel.

A thin flat lever attached to this target projected downward underneath the main panel. When the target was vertical (in the ready position) the thickened end of this lever slipped between a fixed roller and another roller on microswitch #2, separating them about .04 in., which was sufficient to hold the microswitch in the circuit-closed position. When the target was touched and moved slightly, the flat lever slipped out of the rollers, opening

microswitch #2. As the target rotated on its hinge to the horizontal position, the flat lever deflected sideways slightly to slide past a latch, which caught it so that the target would not bounce back and re-close the microswitch, thus re-starting the chronoscope.

Details of the electric circuits and the method of calibration are given in a recent publication from this laboratory (2). It was found that on the basis of 100 tests, the chronoscope used for RT in the present experiment had a constant error of —.003 seconds and a variable error (σ_e) of .0010 seconds. The corresponding figures for the MT chronoscope were —.009 seconds, $\sigma_e = .0013$ seconds.

In order to standardize the longer movement, a horizontal 4-in. hand lever was fastened to a bearing placed on the reaction board 4 in. to the right of the reaction key. The operating handle on this lever was a roller .64-in. high and .38 in. in diameter, held lightly between the thumb and the first two fingers. At the start, the lever was placed so that the handle was over the reaction key, holding it in the down position. At the signal, the subject moved the lever clockwise through one complete circle, the lever being abruptly stopped when it struck a rubber-covered peg mounted just in front of the reaction key. The subject's hand, however, continued in motion forward to the target. Thus, in this operation, the subject's hand moved through a total distance of 36 in. without a pause or slowing. In both the short and longer movements, the fingers were fully extended when they touched the target.

The reason for using a one-plane flat target and mechanically operated movement switch in preference to a light beam and photocell arrangement was to avoid errors that may occur in the associated relays (2) and variability in the part of the hand and the portion of the beam involved in triggering the movement relay.

Subjects and Procedure. Only right-handed subjects were tested. There were three groups of 50 individuals each. These had the age ranges 10-13 years (designated the younger group), 19-25 years (designated the college group), and 40-55 years (designated the older group). All subjects were white male volunteers. Most numbers of the younger group were secured from the University Recreation School, which has a large enrollment from faculty families. Others were secured from the YMCA. The college age subjects came from physical education classes or from students contacted while working out in the gymnasium. The older subjects were predominantly University faculty members contacted during recreational use of the pool or gymnasium, although about a fourth were high school teachers or administrators attending summer session graduate courses. The subjects may therefore be described in a general way as drawn from the physically active portion of a University population. It must be firmly stated that the subjects were not selected to have any particular movement speed or reaction time, or to have a tendency either toward or away from a correlation between RT and MT.

Standardized instructions and procedures were used, and distractions were avoided. All subjects were first given 50 trials with the short direct arm

thrust, after a demonstration by the experimenter. During a brief rest period after the 50 trials, the longer circular movement was demonstrated. Two trials were given without the signal, followed by 60 trials that were recorded. The complete series of tests usually required 30 minutes for completion. In order to allow somewhat for practice effects, only the last 30 trials for each movement have been used in the statistical analysis.

Experimental Results and Discussion

Age Differences. The mean times required for reaction and movement are given in Table 1. The college age group has a faster RT and a faster MT than either of the other groups; the differences are all statistically significant, with t-ratios ranging from 3.47 to 7.44, with the single exception that the long movement MT for the younger group yields a t-ratio of only 1.88. The older and younger groups do not differ significantly in either of the RT's or in the short movement MT; the t-ratios range from 0.06 to 1.36. The older group is, however, significantly slower than the younger group in MT for the long movement ($t = 3.84$). In rough figures, the advantage of the college group as compared with the younger or older groups is about 12 to 14 percent for both RT and MT.

Reliability of Individual Differences. The half-test reliability coefficients, computed by the split-half method, are also given in Table 1. They tend to be somewhat lower in the younger subjects, particularly in the case of RT, but when corrected to full-test values by the Spearman-Brown method the lowest is .90, and the higher ones are .98 or .99.

TABLE 1.—STATISTICAL SUMMARY OF REACTION TIME AND MOVEMENT TIME DATA*

		Short Movement		Long Movement	
Group	Statistic	RT_1	MT_2	RT_1	MT_2
Age 11.4 yrs.	M (sec.)	.2214	.1059	.2190	.3937
$\sigma=0.94$	σ	.0250	.0191	.0206	.0614
N=50	r_{11}	.8174	.9029	.8123	.9297
n=30	r_{12}	—	.0227	—	.2278
Age 22.2 yrs.	M (sec.)	.1937	.0923	.1900	.3693
$\sigma=1.97$	σ	.0215	.0197	.0179	.0669
N=50	r_{11}	.9407	.9747	.8805	.9865
n=30	r_{12}	—	.3183	—	.1053
Age 47.8 yrs.	M (sec.)	.2211	.1093	.2122	.4470
$\sigma=4.55$	σ	.0274	.0232	.0284	.0752
N=50	r_{11}	.9214	.9798	.9439	.9810
n=30	r_{12}	—	.0337	—	.0790

* M represents mean, σ represents standard deviation, N represents the number of subjects, and n the number of measurements made on each of them, r_{11} is the reliability coefficient and r_{12} is the correlation between variables 1 and 2.

Correlations between RT and MT. As may be seen in Table 1, the intercorrelations are .023, .318, and .034 for the short movement in the three age groups. If there is any age pattern in these correlations, it is the mirror image of the tendency found by Pierson. None of them are statistically significant in their difference from zero, using the .01 probability criterion that was used by Pierson. Even when fully corrected for attenuation, the largest correlation is only .325, which is not significant by that standard. For the long movement, one of the correlations is also larger than the other two, but in this case it is the younger group that yields the large correlation. It is .228, which is still nonsignificant (.245) after correction for attenuation. The correlation for the college group is .105 and for the older group it is .079; these become .109 and .081 after correction.

Since the RT-MT correlations show no significant intergroup differences for the three age groups, they may be averaged by the z-transformation to obtain the best estimate of the relationship in the 150 subjects. For the short movement $r = .127$, while for the long movement it is .138. Neither of these differs significantly from zero. It should be noted that age is relatively homogeneous within each group, and the correlations between age and RT or age and MT within the groups are approximately zero, ranging from .034 to .091 with one exception, namely the correlation of age with MT in the older group. In this case, it is .408 for the short movement, which is significant. With the long movement, however, the correlation is not significant, since it is only .203. The relatively larger correlation in the one situation is therefore considered to represent an aberrant value such as may be expected to occasionally appear as a result of random error.

A higher correlation between RT and MT would be found in a sample that is heterogeneous with respect to age, since both RT and MT are larger for ages that are considerably less or considerably more than the college age range. To illustrate this point, the RT-MT correlation has been computed for the pooled 150 subjects for the short movement. The resulting figure is .231, which is statistically significant and noticeably higher than the within-group average of .127.

Intertask Correlations. Individual mean RT's as between the two movements correlate .527 for the younger group, .653 for the college group, and .671 for the older group. These values become .587, .686, and .695 after correction for attenuation. The corresponding correlations for MT's are .468, .597, and .412 before correction, and .489, .603, and .416 after correction.

These results can most readily be interpreted by use of the well-known relationship $(r^2 \times 100) + (k^2 \times 100) = 100$, remembering that the error variance, i.e., unreliability, has been removed from the correlations by correcting them for attenuation. It follows that the percentages of individual differences in RT that are common to the two motor tasks $(r^2 \times 100)$ are 34.5, 47.1, and 48.3 in the three different groups of subjects. This means that reaction time ability is task-specific $(k^2 \times 100)$ to a considerable extent,

since more than half of the individual difference variance in RT is specific to each task, and less than half is of a nature that could be called "general ability to react quickly" by moving the hand and arm. The finding of task specificity in RT is not entirely unanticipated, since Henry has shown that the complexity of the motor movement that is initiated by a simple reaction to a stimulus has a large influence on RT. It may be assumed that the amount of this effect would be different among individuals.[2]

The percentages of individual difference variance in MT that are common to the two movements are only 23.9, 36.4, and 17.3. Task specificity in net speed of movement is therefore quite high in these two arm movements. Individual differences in speed of movement ability measured by one of these tasks cannot effectively predict speed of movement ability in the other task.

In order to demonstrate in another and simpler way that there is task specificity in the individual abilities to react quickly as well as move quickly in these two right-arm movements, the older group RT scores for trials 31-60 in the long movement have been correlated with the scores for trials 1-30. This correlation is necessarily watered down because there must be a learning factor in the early trials. Nevertheless, it is .869, which is to be compared with the correlation of only .671 between trials 31-60 in the long movement and the last 30 trials in the short movement. Stated as a percentage of common variance, the figure is 75.5 compared with 45.0 (neither being corrected for attenuation). Fully corrected for attenuation, there would be 100.0 percent common variance in two measures of RT for the same movement compared with only 59.6 percent in common for the RT's for the two different tasks. A comparable analysis of the MT's gives a correlation of .887 between trials 1-30 and trials 31-60 of the long movement, compared with .412 for the correlation between MT of the two tasks, using the last 30 trials for each task. The common variance is therefore 78.7 percent compared with 17.0, uncorrected, or 100.0 compared with 21.6 percent when fully corrected.

Summary and Conclusions

Three groups of 50 subjects each, having nominal mean ages of 12, 22, and 48 years, were tested as to reaction time and net speed of movement in a short arm-thrust and a longer arm movement with a circular component. Each group was relatively homogeneous in age, the relative variability ranging from 8.2 to 9.5 percent.

Fifty trials per subject were made with the short movement, followed by 60 with the long movement. Only the last 30 of each were analyzed. The average RT of the 22-year-old subjects was .192 sec.; the average MT was .092 sec. for the short movement and .369 sec. for the long movement. The

[2] Data presented and discussed in a paper by Franklin M. Henry, read before the Research Section at the AAHPER Annual Meeting, Chicago, 1956, entitled "Conditions Which Cause Slowing of Reaction Time."

12-year-old subjects were 15 percent slower than the 22-year-olds in RT and short MT, and 7 percent slower in long MT. The 48-year-old subjects were 13 percent slower than the 22-year-olds in RT, 18 percent slower in short MT and 21 percent slower in long MT. All of the differences were significant with the exception of the 7 percent figure, which yielded a t-ratio of only 1.88. There was no significant difference between the 12-year-old and the 48-year-old subjects.

The reliability of individual differences in both RT and MT was relatively high, the coefficients ranging from .90 to .99. There were no statistically significant correlations between RT and MT in any of the age groups. The average for all groups was $r = .127$ for the short movement and .138 for the long movement.

The average proportion of individual differences in movement speed ability that was common to the two motor tasks was only 25.9 percent, compared with 74.1 percent task specificity. Individual differences in speed of reaction were 56.7 percent task specific and 43.3 percent general reaction ability.

These results lead to the conclusions that junior high school age boys, as well as middle-aged men, are slower than college-age men in both speed of movement and reaction time. For the age range studied, reaction time ability and speed of movement ability are uncorrelated; there is no influence of age on this relationship. There is more task specificity than general speed ability among individual differences in speed of movement, even for two movements that have a considerable common element. This generalization also holds, although to a lesser degree, for individual differences in reaction time ability.

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(Submitted 9/16/59)

Relationship of Personality Traits to Motor Ability[1]

J. BURTON MERRIMAN
Nebraska State Teachers College
Wayne, Nebraska

Abstract

In this study the California Psychological Inventory (CPI) and the Phillips JCR Test were administered to 808 high school boys. For purposes of comparison the subjects were classified as follows: upper and lower motor-ability groups; athletes and nonathletes matched according to motor-ability scores; and participants in team sports, participants in individual sports, and participants in team-individual sports.

The upper motor-ability group scored significantly higher than the lower motor-ability group on the measures of poise, ascendancy, and self-assurance and on the measures of intellectual and interest modes.

Few significant differences were found between mean CPI scores when the athletes and nonathletes were matched according to motor ability. Few significant differences were found between mean CPI scores for participants in team sports, participants in individual sports, and participants in team-individual sports. The results of this study indicate that motor ability is related to personality traits.

PHYSICAL EDUCATORS and athletic directors advocate participation in physical activities for the development of desirable character and personality traits. Studies which show that the personality traits of athletes differ from the personality traits of nonathletes have been reported by Carter and Shannon (3), Booth (2), Sperling (14), and Stish (15). Motor ability might be a factor contributing to these differences in personality traits, for athletes generally possess a higher degree of motor ability than do nonathletes. However, all boys who go out for interscholastic athletics do not possess a high degree of motor ability, and all boys who possess a high degree of motor ability do not go out for athletic teams.

The primary purpose of this study was to determine the relationship between motor ability (as measured with the Phillips JCR Test) and personality traits (as measured with the California Psychological Inventory). A secondary purpose of this study was to determine differences between personality scores of the subjects who scored in the upper 25 percent in motor ability and the personality scores for the subjects who scored in the lower 25 percent in motor ability, differences between personality scores of athletes and nonathletes, and differences between personality scores of participants in individual sports, participants in team sports, and participants in team-individual sports.

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[1] This study was made in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Division of Physical Education in the Graduate College of the State University of Iowa, 1959, under the direction of Louis E. Alley, Division of Physical Education, and Leonard D. Goodstein, Department of Psychology.

Procedure

The subjects for this study were 808 boys from two (Muscatine High School and Iowa City High School)[2] four-year high schools in Iowa. The Phillips JCR Test (11) and the California Psychological Inventory (6) were administered to each subject at the beginning of the 1958-59 school year.

The JCR Test consists of a vertical jump, chinning, and a 100-yd. shuttle run over a 10-yd. course, administered in the order listed. The test purports to measure the ability to perform fundamental motor skills.

The California Psychological Inventory is composed of 18 scales which make up four main classes: Class I—measures of poise, ascendancy, and self-assurance; Class II—measures of socialization, maturity, and responsibility; Class III—measures of achievement potential and intellectual efficiency; and Class IV—measures of intellectual and interest modes. The scales are described in the California Psychological Inventory Manual (6).

Analysis of Data

The raw scores for the three items (jump, chins, and run) of the JCR Test were converted into standard scores according to the norms provided for that test, and were totaled. The raw scores for the 18 personality scales in the CPI were used in the final analysis. Three CPI scales are intended to detect the subjects who deliberately exaggerate or otherwise distort their responses to the inventory. These scales are the good impression scale (Gi), the well-being scale (Wb), and the communality scale (Cm). In accordance with the purposes of these scales, the subjects with raw scores of 19 or above on the Gi variable, 23 or below on the Wb variable, and 14 or below on the Cm variable were not included in this study.

The data were analyzed to determine the significance of the differences between the means of the CPI scores for the subjects who scored in the upper 25 percent in motor ability and the means of the CPI scores for the subjects who scored in the lower 25 percent in motor ability; the significance of the differences between the means of the CPI scores of the athletes and the nonathletes; the significance of the differences between the means of the CPI scores of the participants in team sports, the participants in individual sports, and the participants in team-individual sports; and the relationship between the JCR scores and the CPI scores.

Classification of Subjects

Upper Motor-Ability Group and Lower Motor-Ability Group. For each grade level the subjects who on the JCR Test scored in the upper 25 percent of their group constitute the upper group, and the subjects who scored in the lower 25 percent of their group constitute the lower group. The upper and

[2] The writer wishes to express his appreciation to the administrators and students of Iowa City High School, Iowa City, Iowa, and Muscatine High School, Muscatine, Iowa, for their interest and cooperation in this study.

lower limits of the motor-ability scores for the upper 25 percent and the lower 25 percent for each grade are as follows: (a) ninth grade, 141 and 192 and 17 and 79; (b) tenth grade, 156 and 230 and 21 and 95; (c) eleventh grade, 168 and 243 and 24 and 109; and (d) twelfth grade, 161 and 243 and 24 and 101.

Athletes and Nonathletes. A subject in the twelfth or eleventh grade was considered an athlete if he had earned at least one major (varsity) letter as a member of a sports team. A subject in the tenth or ninth grade was considered an athlete if he had earned at least one sophomore (junior varsity) or one junior high school letter as a member of a sports team. A subject was considered a nonathlete if he had not gone out for a sports squad when he was in either junior high school or senior high school.

Team Sports Group, Individual Sports Group, and Team-Individual Sports Group. Each athlete was classified into one of three sports groups: (a) team sports group, (b) individual sports group, or (c) team-individual sports group. The team sports group included the athletes who had participated in at least one of the following sports, but not in individual sports: football, basketball, and baseball. The individual sports group included the athletes who had participated in at least one of the following sports but not in team sports: track-and-field athletics, golf, wrestling, tennis, and swimming. The team-individual sports group includes the subjects who had participated in at least one team sport and one individual sport.

Comparison of Upper and Lower Motor-Ability Groups

The F ratio was used to obtain information concerning the variability of the personality scores for the upper and lower motor-ability groups. The z test (critical ratio) was used to test the significance of the differences between the mean CPI scores for the upper and lower motor-ability groups. The 5 percent level was accepted as indicating statistical significance. The results of the comparison of the upper and lower motor-ability groups for the ninth to twelfth grades combined are presented in Table 1. The results, by grade level and for the ninth to twelfth grades combined, are summarized in Table 2.

On ten variables the upper motor-ability group of the ninth to twelfth grades combined scored significantly higher than the lower motor-ability group of those grades combined. These variables are

1. Do (dominance)
2. Cs (capacity for status)
3. Sy (sociability)
4. Sp (social presence)
5. Sa (self-acceptance)
6. Wb (sense of well-being)
7. To (tolerance)
8. Ac (achievement via conformance)
9. Ai (achievement via independence)
10. Ie (intellectual efficiency).

TABLE 1.—SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS OF CPI VARIABLES FOR UPPER (N=201) AND LOWER (N=201) MOTOR ABILITY GROUPS (FOR NINTH- TO TWELFTH-GRADE COMBINED)

Variables	Sources	Mn	SD	F[a]	z[b]
Do	Upper	23.22	5.61	1.15	4.03[c]
	Lower	20.89	6.02		
Cs	Upper	15.87	3.64	1.46[c]	3.62[c]
	Lower	14.41	4.39		
Sy	Upper	22.46	5.03	1.18	4.69[c]
	Lower	20.00	5.46		
Sp	Upper	33.67	5.40	1.42	4.35[c]
	Lower	31.09	6.44		
Sa	Upper	19.09	3.89	1.13	4.65[c]
	Lower	17.23	4.14		
Wb	Upper	33.60	5.88	1.38	2.13[c]
	Lower	32.23	6.91		
Re	Upper	26.87	6.13	1.26	1.09
	Lower	26.16	6.89		
So	Upper	36.04	6.76	1.35	.90
	Lower	35.38	7.86		
Sc	Upper	26.20	8.44	1.04	.24
	Lower	26.18	8.27		
To	Upper	19.12	5.13	1.32	2.86[c]
	Lower	17.55	5.89		
Gi	Upper	14.77	5.96	1.07	.30
	Lower	14.59	6.18		
Cm	Upper	23.31	2.20	2.95[c]	2.42[c]
	Lower	24.05	3.78		
Ac	Upper	22.81	5.28	1.30	2.37[c]
	Lower	21.47	6.02		
Ai	Upper	16.02	4.14	1.04	2.16[c]
	Lower	15.12	4.22		
Ie	Upper	34.03	5.53	1.60[c]	3.31[c]
	Lower	31.95	6.99		
Py	Upper	9.97	3.22	1.06	.59
	Lower	9.38	3.01		
Fx	Upper	9.94	3.69	1.11	.72
	Lower	9.66	3.89		
Fe	Upper	14.62	3.28	1.13	3.59[c]
	Lower	15.84	3.49		

[a]F for P of .025=1.43; df=120, 120.
[b]z for P of .05=1.96.
[c]Significant at 5 percent level of confidence.

Variables 1, 2, 3, 4, 5, and 6 make up Class I (measures of poise, ascendancy, self-assurance), and variables 8, 9, and 10 make up Class III (measures of achievement potential and intellectual efficiency).

TABLE 2.—SUMMARY TABLES—UPPER AND LOWER MOTOR-ABILITY GROUP[a]

Variables	Grade 9	Grade 10	Grade 11	Grade 12	Total
Do	Upper	Upper[b]	Upper	Upper[b]	Upper[b]
Cs	Upper	Upper[b]	Upper[b]	Upper[b]	Upper[b]
Sy	Upper	Upper[b]	Upper[b]	Upper[b]	Upper[b]
Sp	Upper[b]	Upper[b]	Upper[b]	Upper	Upper[b]
Sa	Upper	Upper[b]	Upper[b]	Upper[b]	Upper[b]
Wb	Upper	Upper	Upper	Upper	Upper[b]
Re	Lower	Upper	Upper	Upper	Upper
So	Upper	Upper	Upper	Lower	Upper
Sc	Lower	Upper	Lower	Upper	Upper
To	Upper	Upper[b]	Upper	Upper[b]	Upper[b]
Gi	Lower	Upper	Upper	Upper	Upper
Cm	Upper	Lower	Upper	Lower	Lower[b]
Ac	Upper	Upper[b]	Upper	Upper	Upper[b]
Ai	Upper	Upper	Lower	Upper[b]	Upper[b]
Ie	Upper	Upper[b]	Upper[b]	Upper	Upper[b]
Py	Upper	Upper[b]	Lower	Upper	Upper
Fx	Upper	Lower	Lower	Upper	Upper
Fe	Lower[b]	Lower[b]	Lower	Lower	Lower[b]

[a]Upper means that the mean of the CPI scores for the upper motor-ability group is greate than the mean for the lower motor-ability group. Lower means that the mean of the CPI scores for the lower motor-ability group is greater than the means for the upper motor-ability group.
[b]The difference between the means of the CPI scores for the upper and lower motor-ability groups is statistically significant.

On the Cm (communality) and Fe (femininity) variables the lower motor-ability group of the ninth to twelfth grades combined scored significantly higher than the upper motor-ability group of the ninth to twelfth grades combined.

Comparison of CPI Scores for Athletes and Nonathletes Matched According to Motor-Ability Scores

For purposes of comparison the athletes and nonathletes were matched according to mean motor-ability scores. An analysis of variance in a double-entry table (9) was used to determine whether within the grades and for all the grades combined significant differences exist between the mean CPI scores of the athletes and the mean CPI scores of the nonathletes. The analysis of variance was also used to determine whether significant differences exist between the mean CPI scores of one grade and the mean CPI scores of the other grades. The results appear in Table 3.

Within Grades. No significant differences between the mean CPI scores of the athletes and the mean scores of the nonathletes were found within the grades.

For All Grades Combined. For six variables significant differences were found between the mean CPI scores of the athletes and the mean CPI scores of the nonathletes in all the grades combined. The athletes scored higher than the nonathletes on four variables: Do (dominance), Sy (sociability),

TABLE 3.—ANALYSIS OF VARIANCE OF CPI VARIABLES FOR ATHLETES (N=161) AND NONATHLETES (N=161) MATCHED ACCORDING TO JRC SCORES: BETWEEN GRADES, FOR ALL GRADES COMBINED, AND WITHIN GRADES

Variables	Sources	SS	df	MS	F[a]
Do	Between Grades	110.26	3	36.75	1.51
	For All Grades	259.00	1	259.00	10.61[b]
	Within Grades	110.76	3	36.92	1.51
	Errorterm	7975.61	314	24.40	
	Total	8455.63	321		
Cs	Between Grades	82.44	3	27.48	1.58
	For All Grades	48.52	1	48.52	2.79
	Within Grades	37.20	3	12.40	.71
	Errorterm	5460.94	314	17.39	
	Total	5629.10	321		
Sy	Between Grades	22.35	3	7.45	.25
	For All Grades	429.76	1	429.76	14.54[b]
	Within Grades	11.45	3	3.82	.13
	Errorterm	9279.99	314	29.55	
	Total	9743.55	321		
Sp	Between Grades	369.58	3	123.19	3.54[b]
	For All Grades	524.18	1	524.18	15.07[b]
	Within Grades	66.74	3	22.25	.64
	Errorterm	10920.28	314	34.78	
	Total	11290.28	321		
Sa	Between Grades	102.49	3	34.16	2.43
	For All Grades	209.93	1	209.93	14.92[b]
	Within Grades	61.90	3	20.63	1.47
	Errorterm	4418.09	314	14.07	
	Total	4792.41	321		
Wb	Between Grades	127.09	3	42.36	1.22
	For All Grades	36.09	1	36.90	1.06
	Within Grades	98.45	3	32.82	.94
	Errorterm	10920.82	314	34.78	
	Total	11183.26	321		
Re	Between Grades	316.99	3	105.66	3.02[b]
	For All Grades	20.78	1	20.78	.59
	Within Grades	65.91	3	21.97	.63
	Errorterm	10998.88	314	35.03	
	Total	11402.56	321		
So	Between Grades	157.31	3	52.44	1.24
	For All Grades	19.38	1	19.38	.50
	Within Grades	70.68	3	23.56	.56
	Errorterm	13248.16	314	42.19	
	Total	13495.53	321		
Sc	Between Grades	53.01	3	17.67	.26
	For All Grades	281.37	1	281.37	4.12[b]
	Within Grades	315.38	3	105.12	1.54
	Errorterm	21444.52	314	68.29	
	Total	22094.28	321		

[a]F for P of .05=2.60; df=3, 314
F for P of .05=3.84; df=1, 314
[b]Significant at 5 percent level of confidence.

TABLE 3 CONTINUED

Variables	Sources	SS	df	MS	F[a]
To	Between Grades	204.50	3	68.17	2.30
	For All Grades	3.80	1	3.80	.13
	Within Grades	33.48	3	11.16	.38
	Errorterm	9310.71	314	29.65	
	Total	9552.49	321		
Gi	Between Grades	83.50	3	27.83	.75
	For All Grades	19.88	1	19.88	.54
	Within Grades	84.71	3	28.24	.76
	Errorterm	11611.60	314	36.98	
	Total	11799.69	321		
Cm	Between Grades	131.89	3	43.96	2.56
	For All Grades	5.48	1	5.48	.32
	Within Grades	30.51	3	10.17	.59
	Errorterm	5394.88	314	17.18	
	Total	5562.76	321		
Ac	Between Grades	67.02	3	22.34	.68
	For All Grades	12.33	1	12.33	.37
	Within Grades	38.00	3	12.67	.38
	Errorterm	10360.93	314	32.99	
	Total	10478.28	321		
Ai	Between Grades	137.97	3	45.99	2.58
	For All Grades	2.98	1	2.98	.17
	Within Grades	4.26	3	1.42	.08
	Errorterm	5602.28	314	17.84	
	Total	5747.49	321		
Ie	Between Grades	377.46	3	125.82	3.19[b]
	For All Grades	118.09	1	118.09	2.99
	Within Grades	38.16	3	12.72	.32
	Errorterm	12376.39	314	39.42	
	Total	12910.10	321		
Py	Between Grades	16.80	3	5.60	.76
	For All Grades	4.25	1	4.25	.57
	Within Grades	12.90	3	4.30	.58
	Errorterm	2326.15	314	7.41	
	Total	2360.10	321		
Fx	Between Grades	60.63	3	20.21	1.49
	For All Grades	.03	1	.03	.00
	Within Grades	55.42	3	18.47	1.37
	Errorterm	4249.28	314	13.53	
	Total	4365.36	321		
Fe	Between Grades	37.99	3	12.66	1.13
	For All Grades	87.65	1	87.65	7.85[b]
	Within Grades	8.20	3	2.73	.24
	Errorterm	3506.94	314	11.17	
	Total	3640.78	321		

[a] F for P of .05 2.60; df 3, 314
F for P of .05 3.84; df 1, 314
[b] Significant at 5 percent level of confidence.

Sp (social presence), and Sa (self-acceptance). The nonathletes scored higher than the athletes on the Sc (self-control) and Fe (femininity) variables.

Between Grades. For three variables significant differences were found between the grades Sp (social presence), Re (responsibility), and Ie (intellectual efficiency).

Comparison of Team-Individual, Team, and Individual Sports Groups

The statistical procedure used in the comparison of the mean CPI scores of the upper and lower motor-ability groups was also used in the comparison of the mean CPI scores of the team-individual, team, and individual sports groups. Since only a few subjects could be classified as participants in individual sports, only comparisons for all the grades combined were made. The results of the comparison between the team-individual sports group and the team sports group is presented in Table 4.

Team-Individual and Team Sports Groups. Significant differences between the mean CPI scores for the participants in team-individual sports and the mean CPI scores for the participants in team sports were found for four variables. On all four variables—Cs (capacity for status), Sy (sociability), Re (responsibility), and Ie (intellectual efficiency)—the mean scores for the participants in team-individual sports are higher than the mean scores for the participants in team sports.

Team-Individual and Individual Sports Groups. No significant differences were found between the mean CPI scores of the participants in team-individual sports and the mean CPI scores of the participants in individual sports. The results of this comparison are not included in the tables presented.

Individual and Team Sports Groups. A significant difference between the mean CPI scores for the participants in individual sports and the mean CPI scores of the participants in team sports was found on one variable. On this variable—Ie (intellectual efficiency)—the participants in individual sports have a higher mean score than the participants in team sports. The results of this comparison are not included in the tables presented.

Relationship Between Personality Scores and Motor-Ability Scores

The Pearson product-moment r was used to determine the relationship between the scores on the motor-ability test and the scores on the 18 variables. Coefficients of correlation were computed for all the subjects by grades and for the ninth to twelfth grades combined. The results appear in Table 5.

For all the grades combined, statistically significant r's ($P = .05$) were found between the motor-ability scores and each of the following personality variables: Do (dominance), Cs (capacity for status), Sy (sociability), Sp (social presence), Sa (self-acceptance), Wb (sense of well-being), To (tolerance), Ac (achievement via conformance), Ai (achievement via independence), Ie (intellectual efficiency), Py (psychological-mindedness), and Fe (femininity).

TABLE 4.—SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS OF CPI SCORES FOR PARTICIPANTS IN TEAM-INDIVIDUAL SPORTS (N=114) AND IN TEAM SPORTS (N=52)

Variables	Sources	Mn	SD	F[a]	z[b]
Do	Team-individual	23.14	5.54	1.36	1.13
	Team	22.19	4.75		
Cs	Team-individual	16.01	3.54	1.43	2.21[c]
	Team	14.52	4.23		
Sy	Team-individual	23.13	4.71	1.27	2.93[c]
	Team	20.62	5.30		
Sp	Team-individual	34.43	6.07	1.28	1.83
	Team	32.71	5.37		
Sa	Team-individual	19.03	3.54	1.01	1.48
	Team	18.15	3.52		
Wb	Team-individual	34.17	5.05	1.56	1.60
	Team	32.58	6.32		
Re	Team-individual	26.81	5.74	1.14	1.97[c]
	Team	25.94	5.37		
So	Team-individual	37.13	5.79	1.55	1.79
	Team	35.10	7.20		
Sc	Team-individual	25.82	8.34	1.03	.32
	Team	25.37	8.45		
To	Team-individual	19.05	5.31	1.13	1.69
	Team	17.48	5.64		
Gi	Team-individual	14.82	6.09	1.03	.56
	Team	14.25	6.01		
Cm	Team-individual	24.33	4.10	1.11	1.11
	Team	23.60	3.90		
Ac	Team-individual	22.69	5.88	1.17	1.32
	Team	21.46	5.44		
Ai	Team-individual	15.43	3.61	1.42	.40
	Team	15.15	4.29		
Ie	Team-individual	34.91	5.41	1.72	3.53[c]
	Team	31.00	7.09		
Py	Team-individual	10.00	2.53	1.02	1.46
	Team	9.38	2.51		
Fx	Team-individual	9.83	3.85	1.21	1.20
	Team	10.56	3.49		
Fe	Team-individual	14.33	3.39	1.04	1.50
	Team	15.17	3.32		

[a]F for P of .025=1.82; df=30, 60; F for P of .025=1.80; df=60, 40
[b]z for P of .05=1.96
[c]Significant at 5 percent level of confidence.

Summary

A number of statistically significant differences between mean CPI scores for the upper motor-ability group and mean CPI scores for the lower motor-ability group were found. For the ninth to twelfth grades combined, the upper motor-ability group scored significantly higher on ten variables than the lower motor-ability group. The lower motor-ability group scored significantly higher than the upper motor-ability group on two variables.

TABLE 5.—CORRELATION COEFFICIENTS FOR CPI PERSONALITY VARIABLES AND MOTOR ABILITY SCORES FOR EACH GRADE (9TH, 10TH, 11TH, AND 12TH) AND FOR TOTAL GRADES

Variables	Grade 9 (N=234)	Grade 10 (N=220)	Grade 11 (N=189)	Grade 12 (N=165)	Total (N=808)
Do	.13	.13	.16[a]	.17[a]	.16[a]
Cs	.07	.19[a]	.10	.18[a]	.16[a]
Sy	.11	.16[a]	.20[a]	.21[a]	.19[a]
Sp	.22[a]	.16[a]	.21[a]	.17[a]	.22[a]
Sa	.16[a]	.19[a]	.17[a]	.17[a]	.21[a]
Wb	.05	.10	.14	.01	.10[a]
Re	.01	.06	.03	.01	.05
So	.06	.04	.09	—.07	.05
Sc	—.05	.04	—.07	.04	—.02
To	.09	.16[a]	.06	.18[a]	.14[a]
Gi	—.10	.07	—.01	.03	—.02
Cm	.02	—.02	.07	—.08	.05
Ac	.05	.14[a]	.04	.07	.09[a]
Ai	.05	.11	—.01	.21[a]	.11[a]
Ie	.08	.17[a]	.16[a]	.14[a]	.16[a]
Py	.11	.21[a]	—.06	.10	.11[a]
Fx	.01	.02	.00	.10	.05
Fe	—.11	—.20[a]	—.11	—.08	—.13[a]

[a]Significant at 5 percent level of confidence.

For the ninth to twelfth grades combined, six statistically significant differences were found between mean CPI scores for athletes and mean CPI scores for nonathletes matched according to motor-ability scores. The athletes scored significantly higher than the nonathletes on four variables. The nonathletes scored significantly higher than the athletes on two variables. Within grades no significant differences were found between the mean CPI scores of the athletes and the mean CPI scores of the nonathletes.

Statistically significant differences between the mean CPI scores for the participants in team-individual sports and the mean CPI scores for the participants in team sports were found for four variables. On these four variables the mean scores of the participants in team-individual sports are higher than the mean scores for the participants in team sports. For one variable, the participants in individual sports scored significantly higher than the participants in team sports. No statistically significant differences were found between the mean CPI scores of participants in team-individual sports and the mean CPI scores of participants in individual sports.

For the ninth to twelfth grades combined, statistically significant r's ($P = .05$) were found between the motor-ability scores and the CPI scores for 12 variables.

Conclusions

On the basis of the findings in this study, it is concluded that:

1. Motor ability is related to personality traits.

2. The upper motor-ability group scored significantly higher than the lower motor-ability group on the measures of poise, ascendancy, and self-assurance and on the measures of intellectual and interest modes.

3. From the fact that few significant differences in personality traits were found when athletes and nonathletes were matched according to motor-ability, the inference might be drawn that motor-ability rather than participation in athletics is a potent factor in the development of personality traits.

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(Submitted 8/20/59)

Brachial Pulse Wave as a Measure of Cross-Country Running Performance[1]

HENRY J. MONTOYE
WILLIAM MACK[2]
JOHN COOK[3]
Michigan State University
East Lansing, Michigan

Abstract

Resting brachial pulse waves were recorded on 48 of the 68 participants in the NCAA cross-country championship race. Various measurements of the pulse wave were correlated with the official run time of the performers. Most of the measurements were significantly related to run time, but the coefficients of correlation were low. Pulse rate gave the highest coefficient, 0.52. Dividing the pulse wave measurements by surface area of the subject did not improve the relationships.

IT IS APPARENT that circulatory condition plays an important role in long-distance running. The scientist, as well as the coach, is interested in knowing precisely how much this factor and others contribute to performance. In all likelihood, the coach will not select members of a cross-country team exclusively on the basis of circulatory condition, but this may be one of the factors. Also, illustrating the relationship between athletic performance and condition of the circulatory system with actual data should be of considerable motivational value.

That the heart rate decreases with conditioning has long been general knowledge. The slower heart rates of trained athletes compared to untrained subjects and the comparison between wild animals and domestic animals give further support of the effects of training on heart rate (9). This has generally been interpreted as evidence that the resting stroke volume has increased. A recent study demonstrated that the resting stroke volumes of trained subjects are larger than those of untrained individuals (7). There is also evidence that the resting arterio-venous oxygen difference increases with training (4,7).

Although the heart rate decreases with training, the crudeness of this measure of circulatory condition is well known. The heart rate is influenced by many factors besides training. Therefore, it is natural for athletic coaches and others to search for a more satisfactory measure of conditioning—perhaps a more direct measure of stroke volume of the heart. This has lead to studies of the brachial pulse wave.

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[1] The help of Karl Schlademan and Francis Dittrich, track coaches at Michigan State University, is gratefully appreciated.

[2] Now located at Marshall, Michigan.

[3] Now located at Washington High School, Port Huron, Michigan.

Viscosity of the blood, thickness and elasticity of the arteries, besides many aspects of the cardiac contraction may affect the characteristics of the pulse wave. When the brachial pulse wave is recorded indirectly, that is, by means of a cuff on the arm rather than intra-vascularly, the tissue surrounding the artery may affect the waves. For example, the blood pressure recorded with a cuff at the femoral artery may be twice as high as that recorded the same way on the arm. When the intra-arterial blood pressure is recorded in these two places, the femoral pressure is only greater by a few millimeters of mercury. The discrepancy is due to the tissue surrounding the arteries. In addition to these factors, limitations of the recording instrument may produce artifacts. It is not surprising, therefore, that many investigators have been discouraged in attempting to interpret pulse waves in terms of cardiac stroke volume. The interested reader may consult Wiggers (10) for a comprehensive discussion of the hemodynamics related to the pulse wave.

One of the most interesting series of experiments on stroke volume was reported recently by Starr and his associates (8). They developed a technique for pumping blood[4] through cadavers under conditions closely approximating a normal physiological state. The advantage of this technique, of course, is that the stroke volume is known. In one of these investigations, pulse waves were recorded on the cadavers. The waves were recorded intra-arterially and hence were not subject to many of the limitations associated with cuff recording devices. The results indicate that the pulse wave is sufficiently related to stroke volume to merit further study.

Review of Previous Studies

It is inappropriate to present a comprehensive review of the hundreds of studies on the pulse wave, but the pertinent ones relating to training will be discussed. Cureton (1) apparently has been the first physical educator in this country to investigate the usefulness of the pulse wave in athletics. The Cameron Heartometer was used in his studies. This is a cuff-type instrument in which the pulse wave at the brachial artery is recorded. Cureton has compared groups of athletes or others in good physical condition with untrained subjects. Most of the pulse wave measurements differentiated between such groups. In addition, correlation coefficients between an all-out run on the treadmill at seven miles per hour and various pulse wave measurements ranged from 0.012 to 0.555 in young men (1). These coefficients were between 0.251 and —0.480 in trained basketball players and track men. Pulse rate correlated to the extent of 0.263 and —0.056 in these studies. Correlations with performance were lower for blood pressure measurements. Mile run scores and pulse wave measurements were also correlated and the coefficients ranged between 0.015 and 0.448. Resting pulse rate and blood pressure again showed relatively low correlation with performance.

[4] In some experiments, water was used.

Cureton (2) summarized a group of studies showing that pulse wave measurements changed in subjects undergoing a conditioning program. However, the statistical significance of these changes for the most part was not given. Also, only selected pulse wave measurements were reported. When a number of such measurements are studied, some will show relatively large changes due just to chance.

Massey and collaborators (6), using a Cameron instrument, compared groups whose levels of cardiovascular fitness were obviously different. They found systolic and diastolic amplitudes of the pulse wave, particularly when divided by surface area, to differentiate between the groups. Pulse rate differences were not statistically significant. In one of these comparisons the two groups were formed on the basis of their performance in the 880-yd. run.

Henry (5), using a Cameron instrument, compared trained and untrained subjects. Although a number of the differences in the pulse wave measurements were statistically significant, the resting pulse rate produced the largest t-ratio. The trained subjects were also compared in and out of training. Much the same results were secured in this analysis, that is, the resting pulse rate produced the largest t-ratio. He concluded that the resting heart rate change is a more efficient test of changes in athletic condition than the pulse wave measurements.

Van Huss and Cureton (10) correlated pulse wave measurements with oxygen debt and oxygen intake determinations during swimming. The coefficients ranged from 0.233 to 0.479. Pulse wave cycle (pulse rate) produced a coefficient of 0.280 and 0.318 when correlated with these criteria. However, when correlated with 100-yd. and 440-yd. swimming time, the pulse wave cycle coefficients of correlation were 0.325 and 0.403 respectively.

Methods of Procedure

The annual NCAA cross-country championship meet has been regularly held over the four-mile course at Michigan State University during the last decade. On one of these occasions, it was possible to record pulse waves on 48 of the 68 participants. A heavy snowfall limited the number of contestants on this particular occasion. However, the runners included the best collegiate cross-country performers, who represented 19 colleges and universities.

A cardiorespirograph on loan from the Cameron Company of Chicago was used to record pulse waves during the two days preceding the meet. This instrument embodies the heartometer, and in addition it is possible to record respiration. In these tests the men sat quietly for about 30 min. before the records were taken, and no preceding strenuous exercise was permitted on the day of the test. The men had not smoked for two hours prior to the testing, but there were no restrictions on food or liquid intakes. The pulse waves were recorded at various pressures around 80 millimeters to secure maximum waves. All measurements were made according to the procedure recommended by Cureton (1) on three of the waves, and these values were averaged.

Running times were recorded to the closest tenth of a scond at the finish line by NCAA officials.

Results

Run time on the four-mile cross-country course was plotted against age, height, and weight of the runners, and against each of the mean pulse wave measurements. The relationships appeared linear, hence product moment correlation coefficients were computed. Coefficients expressing the correlation between cross-country run time and age, height, and weight were —0.25, —0.22, and —0.06 respectively. None was significant at the 5 percent level of significance. Similar coefficients for run time and pulse wave measurements appear in Table 1. Figure I shows the plot of pulse rate against cross-country run time.

Inasmuch as Massey and co-workers (6) secured slightly higher t-values when the pulse wave measurements were divided by surface area, this procedure was followed in the present study. The correlation coefficient between run time and surface area was —0.15. When the three wave measurements most closely related to run time were divided by surface area, the coefficients of correlation were not improved. Area under the pulse wave divided by surface area when correlated with run time produced a coefficient of —0.31. Systolic amplitude divided by surface area resulted in a coefficient of —0.28. While both of these coefficients are statistically significant at the 5 percent level, they are nonetheless slightly lower than the coefficients produced when the measurements are not divided by surface area. Diastolic pulse wave amplitude divided by surface area resulted in a coefficient of —0.23, which is again slightly smaller than the coefficient for diastolic pulse wave amplitude when not divided by surface area.

It appears that run time is more closely related to pulse rate than to any of the pulse wave measurements (Table 1). However, since several of the other coefficients were statistically significant, these relationships were studied further. Obviously, many of the pulse wave measurements are interrelated.

Table 2 contains the correlation coefficients between pulse rate and the pulse wave measurements which were significantly related to run time. In order to determine whether all of the correlation (predictive value) of the

TABLE 1.—ZERO ORDER CORRELATION COEFFICIENTS BETWEEN CROSS-COUNTRY RUN TIME AND VARIOUS PULSE WAVE MEASUREMENTS

Measurement	Correlation Coefficient	Measurement	Correlation Coefficient
Pulse Rate	.52[b]	Time of Systole	—.32[a]
Systolic Blood Pressure	.13	Time of Diastole	—.21
Diastolic Blood Pressure	.39[b]	Rest/Work Ratio	.03
Pulse Pressure	—.29[a]	Single Cycle Time	—.34[a]
Systolic Pulse Wave Amplitude	—.31[a]	Area Under Pulse Wave	—.37[b]
Diastolic Pulse Wave Amplitude	—.27	Fatigue Ratio	.06
Dicrotic Notch Amplitude	—.30[a]	Angle of Obliquity	.25

[a]Statistically significant; probability between 0.05 and 0.01.
[b]Statistically significant; probability less than 0.01.

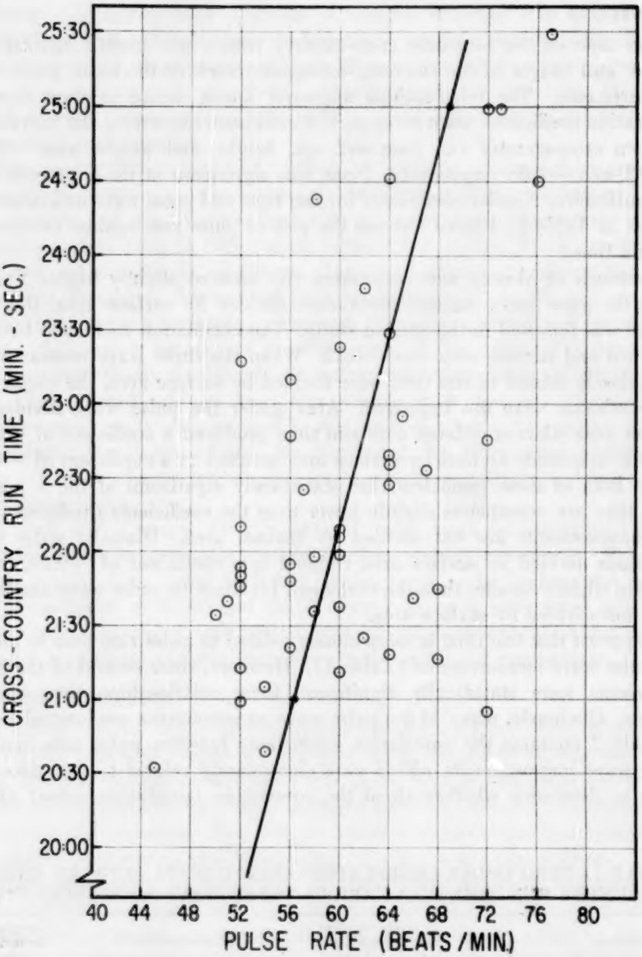

FIGURE I. Relationship between cross-country run time and resting pulse rate.

pulse wave measurements may be explained by the relationship with pulse rate, partial coefficients were computed. The results are shown in Table 3. None of the partial correlations were statistically significant. On the other hand, when pulse rate and run time were correlated, with area under the pulse

TABLE 2.—ZERO ORDER CORRELATION COEFFICIENTS BETWEEN PULSE RATE AND PULSE WAVE MEASUREMENTS

Pulse Wave Measurement	Correlation Coefficient
Diastolic Blood Pressure	.32[a]
Pulse Pressure	—.31[a]
Systolic Pulse Wave Amplitude	—.40[b]
Dicrotic Notch Amplitude	—.47[b]
Time of Systole	—.35[a]
Single Cycle Time	—.85[b]
Area Under Pulse Wave	—.62[b]

[a]Statistically significant; probability between 0.05 and 0.01.
[b]Statistically significant; probability less than 0.01.

TABLE 3.—FIRST ORDER CORRELATION COEFFICIENTS BETWEEN RUN TIME AND PULSE WAVE MEASUREMENTS WITH PULSE RATE PARTIALLED OUT

Pulse Wave Measurement	Correlation Coefficient
Diastolic Blood Pressure	.27
Pulse Pressure	—.16
Systolic Pulse Wave Amplitude	—.16
Dicrotic Notch Amplitude	—.08
Time of Systole	—.18
Single Cycle Time	.22
Area Under Pulse Wave	—.06

wave partialed out, the resulting coefficient of 0.40 was significant with a probability between 0.05 and 0.01. From this analysis it appears clear that the pulse wave as measured by the Cameron cardiorespirograph has no value in predicting cross-country run time other than what can be predicted from the resting pulse rate.

Discussion

The coefficients in the present study, as well as those by previous investigators, are so small as to be of little predictive value. Inasmuch as the subjects on the present study represent a homogeneous group and only the one running time was utilized, smaller coefficients of correlation might be expected than if these conditions were not present. The lower pulse rate among conditioned people and the significant correlation between pulse rate and cross-country run time no doubt reflects an increase in stroke volume. This also explains why the pulse rate is correlated significantly with many of the pulse wave measurements. Cureton (1, 2, 3) and Massey and collaborators (6) reported results which would indicate that the pulse rate is not as good an indication of condition as some of the pulse wave measurements. Henry (5), on the other hand, working with changes of conditioning in athletes, and in comparing untrained and trained subjects, reported results that were very similar to those reported in the present study. In view of Starr's work (8) and the discrepancies noted above, perhaps the study of the pulse wave should continue.

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(Submitted 10/5/59)

Effect of Milk on Short Duration, Sprint, and Power Types of Athletic Performance[1]

DALE O. NELSON
Utah State University
Logan, Utah

Abstract

The purpose of this investigation was to study the effect of varied amounts of milk in a balanced diet as it relates to short duration, sprint, and power types of athletic performance. Since milk contributes substantial amounts of protein to the diet, it was felt that protein might be a contributing factor in any cause and effect relationship between milk, diet, and physical performance. Hence protein at three levels were included as a variable by combining the three amounts with the changing levels of milk. Learning and conditioning tests were conducted before the start of the experiment and for the final three days of each diet period. Performance on the tests used in the study was not altered by the use of one or two quarts of milk per day in the diet as compared to the absence of all milk from the diet. At the different levels of protein used in this study, performance was unchanged.

THERE IS NO DOUBT that milk is an important food in the diet of man, even though many people maintain that it is not the excellent food it is claimed to be. Most controversies have centered chiefly around the diet of people participating in athletics, particularly on the day of competition, although some medical doctors also remove milk from the diet of patients with various types of respiratory disorders. In all cases where the citations are negative, it is said to increase the secretion of mucus in the respiratory system and to form excessive gas in the stomach to the point of interference with performance.

Obviously, not all authors condemn milk. In fact, those who do are in the minority. Belik (1) says:

> Milk is the most nearly perfect food. It contains 12 percent protein, 44 percent carbohydrate, 44 percent fats, iron, copper, calcium, phosphorus, magnesium, vitamins A, B, C, D, G, and K. Milk does not "cut the wind."
>
> It is an easily digestible beverage. When used as a part of a meal, it should be sipped slowly, whereas it is usually gulped in order to wash down the solid food which had preceded it. When thus gulped, milk tends to form large curdles which break up slowly and are digested with difficulty, fermentation and "gas" resulting. When sipped slowly, small easily digestible curdles are formed.

McLester and Darby (3) indicate that milk is the most important of all foods:

[1] This project was supported by a grant from the American Dairy Association and completed under Utah State University Research.

> It is indispensable to the infant, it is essential to the proper development of the young child, and it should form invariably a major article of diet for the older child. For the adult, too, it is always a valuable, and at times essential, adjunct to the diet.

Milk contains 34.2 grams of protein per fluid quart (5). On a 4000 calorie diet where 10 percent of the total calories are protein, one quart of milk furnishes one third of the total protein, and two quarts of milk furnish two thirds of the protein. Consequently, milk is important in its contribution of protein to the diet.

Statement of the Problem

The purpose of this investigation was to study the effect of varied amounts of milk in a balanced diet as it relates to short duration, sprint, and power types of athletic performance. Since milk contributes substantial amounts of protein to a diet, it was felt that protein might be a contributing factor in any cause and effect relationship between milk, diet, and physical performance. Hence protein at three levels was included as a variable. The experimental design permitted a study of milk, protein, and milk and protein combined. Other variables such as fat in the diet have also been mentioned in the literature, but this study could not accommodate more variables.

Subjects

Subjects were 24 Utah State University athletes representing the competitive sports of football, basketball, track and field, and wrestling. All were given physical examinations before starting the experiment and were found to be in excellent condition. They ranged in weight from 135 lbs. to 240 lbs.

Procedure

A 3 $\times$ 3 factorial selection of treatments was used in this experiment. There were three levels of protein (10.0, 13.4, and 16.8 percent of the total calories) and three substitution amounts of milk (0, 1, and 2 quarts per day). These were put together in all combinations, which resulted in nine diets as shown in Table 1A.

It was considered impossible to have each subject remain on the test long enough to be subjected to all nine treatments. Therefore an incomplete block design was selected. The particular incomplete block design used was a 3 $\times$ 3 balanced lattice (2, 10.1 plan). Two subjects were used to create each of the 12 blocks in the design. Each pair of subjects spent 17 days on each of three diets, as shown in Table 1B. A particular diet consisted of an initial three-day adjustment period, followed by two weeks of sustenance on the diet. Measurements were taken on each individual the last three days of the controlled diet period. Milk was consumed on test days the same as other days. This included consumption of milk within one hour of testing.

Learning and conditioning trials on the tests were conducted for three days during the week preceeding the start of the experiment. To ensure maximum

TABLE 1.—EXPERIMENTAL DESIGN

A. Randomization of treatments

Protein[a]	Milk[b]	Treatment
0	0	4
0	1	6
0	2	1
1	0	5
1	1	2
1	2	8
2	0	7
2	1	9
2	2	3

B.

Replications	Block	Subjects	Time Period[c] I	II	III
				Treatments	
1	1	1 and 2	1	2	3
	2	3 and 4	4	5	6
	3	5 and 6	7	8	9
2	4	7 and 8	1	6	8
	5	9 and 10	9	2	4
	6	11 and 12	5	7	3
3	7	13 and 14	1	4	7
	8	15 and 16	2	5	8
	9	17 and 18	3	6	9
4	10	19 and 20	1	9	5
	11	21 and 22	6	2	7
	12	23 and 24	8	4	3

[a]0 = Protein 10 per cent of total calories.
1 = Protein 13.4 per cent of total calories.
2 = Protein 16.8 per cent of total calories.
[b]0 = No milk.
1 = 1 quart per day.
2 = 2 quarts per day.
[c]Each time period was two weeks, preceded by an adjustment period of three days.

performance and cooperation, subjects were paid for the tests and for being on the experiment.

All food was furnished for the subjects in a special kitchen and dining room where cooks and dietitians prepared the meals.[2] Measures were taken to ensure that subjects ate only the food used in the experimental diets. The diets were isocaloric for each subject, and the subjects were weighed each morning so that the same initial weight could be controlled throughout the study. A dietitian adjusted the diet whenever weight changed. All food was carefully weighed and measured before consumption.

No milk was used in the preparation of the food. Fat included 35 percent of the calories, and other nutrients were adequate. Meat consisted of beef round, turkey, halibut, tuna, and veal. Common foods were used throughout

[2] Appreciation is expressed to Ethelwyn B. Wilcox, professor of food and nutrition, who directed the preparation and administration of the diet.

the feeding period. It has been noted that weights of subjects ranged from 135 lbs. to 240 lbs. Calories ranged from 3100 to 4700.

Tests

The gross motor tests were selected to test such basic components as speed and reaction time, power (vertical), and strength and endurance. These items are believed to be a part of athletic types of activity, and the tests have indicated high precision on another study recently completed (4). The tests were given at the same time each day and in the sequence listed so that the effects from one test to another would be uniform.

Test 1. Starting and Running

An upright starting position was used with each subject running 10 yds.. The electric timing device was started by clapping two copper covered boards together. As the sheets of copper came together the clock started and continued until the runner broke the electric circuit by striking a gate switch, waist high, across the finish line. Time was recorded to the nearest 1/100 sec. Each subject's daily score included the average of five timed trials.

Test 2. Vertical Jump

The subject reached as far as possible with heels kept on the floor and made a chalk mark on the wall. He next executed three jumps from a crouched position, making a finger imprint each time on the wall board. The distance from the top of the reach mark to the top of each jump mark was measured. The average of three jumps was used as the daily score.

Test 3. Bicycle Ergometer

Maximum revolutions in 60 sec. against a 10 lb. resistance were used as the daily score.

Results[3]

Since an incomplete block design was used, it was necessary to adjust the treatment means for variations in groups. The analyses of variance are presented for each skill test in Table 2. No significant treatment effect was found except in the starting and running test, which had differences significant at the 10 percent level of confidence. These differences were not considered important, because there was no definite pattern, as indicated in Table 3 containing the adjusted means. Consequently, these differences were attributed to chance. The variations for the vertical jump and bicycle ergometer were not significant.

During all testing on the project, heart rates and blood pressures were taken for each subject under controlled conditions. It was not expected that these tests would be significantly important or indicate radical effects of the varied diets. These data were also analysed with the same procedures used on the gross motor tests, but no significant differences were found, and there was no definite pattern. All were within normal limits.

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[3] Statistics on this project were completed in the Utah State University Statistical Laboratory under the direction of Rex Hurst.

TABLE 2.—ANALYSIS OF VARIANCE OF THE STARTING AND RUNNING, VERTICAL JUMP, AND BICYCLE ERGOMETER TESTS

Source	Degrees of freedom	Starting and running Mean square	Vertical jump Mean square	Bicycle ergometer Mean square
Adjusted treatment	8	.004441(.10)	.1731	338.4
Effective error	16	.001963	.8794	846.4

TABLE 3.—ADJUSTED MEANS[a] AND STANDARD ERROR OF THE MEANS

Quarts of milk per day		Protein (percent of total calories) 10.0	13.4	16.8	Average
		Starting and Running (*seconds*) Standard error = .0157			
0		2.1641	2.1361	2.1564	2.1522
1		2.1254	2.1291	2.1591	2.1379
2		2.1879	2.1458	2.1188	2.1508
	Average	2.1591	2.1370	2.1447	
		Vertical Jump (*inches*) Standard error = .3315			
0		21.4011	21.2891	21.5434	21.4112
1		21.4165	21.4429	21.7650	21.5415
2		21.3209	21.6016	21.5830	21.5018
	Average	21.3795	21.4445	21.6305	
		Bicycle Ergometer (*revolutions*) Standard error = 10.28			
0		314.59	314.38	317.10	315.36
1		314.04	306.06	325.08	315.06
2		305.87	311.98	323.66	313.83
	Average	311.50	310.81	321.95	

[a] Adjusted for blocks according to Cochran and Cox (2).

Discussion

The incomplete block design used in the study appeared to be very efficient since the block mean squares were highly significant for all types of data. The coefficient of variation of a mean for the three types of data were as follows: starting and running—.073 percent; vertical jump—1.54 percent; and bicycle ergometer—3.27 percent. These coefficients of variation indicate a satisfactory experimental precision which is adequate to have detected any real differences that might have occurred. The starting and running skill indicated differences in treatment variation significant at the 10 percent level of confidence, but this seemed to be due to the high precision of this test, as noted above.

Claims in athletic circles are that milk adversely affects performance as a result of increasing the secretion of mucus and forming excess gas in the stomach. In this carefully controlled study, in which use of milk was compared with no milk, these claims were not substantiated; they appear to be based on opinion only. If real differences had existed it seems they would have been detected. It is, therefore, concluded that the experiment under these conditions and with these subjects was sensitive enough, but real differences did not exist.

It should be mentioned that the tests used were predominantly sprint and power types of performance, although the subjects were in much the same condition after the bicycle ergometer as a man finishing a 440-yd. dash. The maximal effort ride for 60 sec. on the bicycle ergometer was believed to have some relationship to endurance types of performance, even though it is recognized that longer duration types of performance may not yield the same results.

Two quarts of milk per day is considered a high level in any diet, and one quart per day is often recommended for men participating in athletics. An examination of the test scores in Table 3 shows that the results are as good when large amounts of milk were consumed as they were when milk was removed from the diet. There was a tendency for one quart of milk and the high protein to coincide with best performance. All of this appears to be significant, since wide differences in performance were not found in a balanced diet with or without milk.

It seems that a diet adequate in every respect contributes the necessary fuel for the body to perform well in big muscle activity. Since milk is an excellent source of many of the required nutrients, it should be recommended in the diet of athletes. It would not appear that coaches and participants should be alarmed over its use on the day of competition. It is postulated that much of the controversy centered around milk and increased secretion of mucus could be eliminated with further study of the relation of stress and excitement to these physiological changes. It seems that the stress of competition causes the mouth to become dry and that activity itself brings about abnormal amounts of mucus in the respiratory system.

The same can be said about the levels of protein as was said about the amounts of milk. All levels of protein were considered adequate, but no wide differences were found when the amounts were varied to include unusually high levels of protein. This indicates that as long as protein is adequate in the diet the amount, whether in milk or not, does not make any difference on the performance as measured by these tests. It should be mentioned that when 10 percent of the total calories in a 4000 calorie diet is protein (which was the low protein diet), one quart of milk daily furnished one-third of the total protein needed in the diet. Where small men were concerned and 3000 calories were used, one quart of milk contributed approximately one-half of the total protein.

Although findings were not significant, protein seemed to be the center of some interesting observations. The low protein diet did not appear to be adequate, since most of the subjects complained of being hungry part of the time, yet their weights did not fluctuate. Conversely, the high protein diet seemed to make them lack any feeling of hunger, even at meal time.

It may also be noted in Table 3 that the high protein diet and the one quart of milk per day indicated the best scores on the vertical jump and the bicycle ergometer, although these differences were not found to be significant.

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(Submitted 8/20/59)

Relation of Circuit Training to Swimming[1]

DEREK N. NUNNEY
University of California
Los Angeles, California

Abstract

The primary purpose of this study was to determine the relationship between circuit training and the improvement of endurance, speed, weight, and strength of swimmers during a six-week training period. Two groups of 12 college men were equated on the basis of distance swum in a 15-minute endurance test using the front crawl only. Both groups were also tested for swimming speed over 33⅓ yd., height, weight, and ability to perform dips, chins, vertical jump, and push-ups. The experimental group combined circuit training and swimming in the program, but the control group had swimming only. It was found in the re-test at the end of six weeks, that the experimental group had made significant gains in swimming endurance and speed, weight, and ability to perform chins and push-ups. The control group made significant gains in swimming endurance and weight. It was also noted that the control group had a marked tendency to lose strength as measured by ability to perform chins, vertical jump, and push-ups. The experimental group made significantly greater gains than the control group in weight and chins. The increase in swimming speed by the experimental group was significantly greater than the control group at the 5.26 level of confidence. There was no significant evidence to show that the circuit training, which included weight training exercises, was in any way detrimental to swimming performance.

THE USE OF land exercise to improve swimming ability has been a controversial issue for many years. Similarly, the acceptance of weight training in conditioning programs for any games or sports has long been a point of dispute (18). Many of the arguments presented for, or against, either of these issues have been based on opinion or limited observation. Circuit training is a method of land exercise including the use of weights, which has been subjected to limited scientific study.

It was the purpose of this study (a) to determine the extent to which circuit training is of assistance when attempting to increase the endurance, speed, and strength of swimmers; (b) to show the relation between circuit

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[1] This study was completed at the University of California, Los Angeles, under the guidance of Wayne W. Massey and Ruth Abernathy (physical education), and Donald S. MacKinnon (medicine).

Circuit training is a method of training which utilizes the principle of progressive resistance or loading, and includes exercises with and without weights. One essential feature is the circular arrangement of the activities, designed to facilitate training by large groups. A further feature is the work load, which comprises three sets of repetitions of each activity at submaximal capacity, to be completed within a certain time limit. This method was devised by R. E. Morgan and G. T. Adamson of the University of Leeds, England, and is fully described in the book entitled *Circuit Training.*

training and changes in height and weight; (c) and to consider the feasibility of combining two 15-min. sessions of circuit training with a weekly swimming program consisting of three 30-min. sessions, without detrimental effect on swimming improvement.

The desire to improve the speed, endurance, strength, and technique of swimmers is present with all swimming teachers and coaches. However, there are different opinions concerning the most efficient methods whereby these objectives might be attained. Efforts to effect improvement have been conducted through the approach of variations in stroke technique, in all recognized swimming styles. There have also been attempts to facilitate swimming ability through the utilization of training methods which include water and land exercises.

In recent years enthusiasts for land exercises have contemplated the incorporation of weight training into their programs. In some instances it has been carried into practice. Nevertheless, many swimming coaches have viewed the use of weight training as detrimental to swimmers, and have excluded it. This belief that weight training is a harmful factor in swimming programs has been based on conjecture, which has persisted regardless of the apparent successes achieved by those who have accepted this training method. These differences of opinion, which are not necessarily based on scientific evidence, prompted this investigation.

The circuit training method of land exercise was used because it includes exercises with and without weights, also because organization and administration of the method is appropriate to the normal physical education program. Furthermore, with the apparent acceptance of progressive resistance exercises (6), and with the obvious need for a teaching method by which such exercises can be readily introduced into school programs, the investigation of circuit training appeared to be timely.

Circuit training is a method of presenting exercise which, although new to the United States, might have wide value in physical fitness and conditioning programs. It has been used quite extensively in England since 1956 and has been accepted in many schools and sports clubs in that country.

Procedure

The subjects for the study were members of an intermediate swimming class which was a section in the program organized by the Department of Physical Education, for the general college students at the University of California, Los Angeles. The university regulations require that lower division students enroll in a swimming course as part of their physical education requirement. However, before participationg in the study, the students were presented with complete information of the problem and proposed procedure. Volunteers were then requested to signify their willingness to participate. The complete class of 24 students volunteered.

This discussion with the class was held six weeks after the beginning of the fall semester, 1958. During the six-week period, the class had been in-

structed in the crawl swimming stroke and had arrived at a state of physical condition which suggested that there would be no danger in pursuing the proposed program.

The total length of time involved was eight weeks. Of this, the first and last weeks were devoted to testing, leaving six weeks for the experiment. The period of the year, October 27 to December 19, 1958, was not an important factor as far as climate was concerned. The Los Angeles area experienced an extended drought and high temperatures during this period. On all testing days the air temperature readings were above 70°F., and the water temperature was maintained at 80°F. An outdoor swimming pool was used.

One prime concern of the study was with improvement in swimming endurance as measured by the number of lengths of the pool each subject could swim in 15 min. Therefore, the two groups, experimental and control, were selected on the basis of the results of the first 15-min. endurance test. The 24 subjects were paired to produce two groups of 12 subjects equalized in swimming endurance as determined by the number of lengths swum.

These two groups were designated as follows: Group A—experimental group, and Group B—control group. The final placing of the subjects into either Group A or B was on pure chance selection.

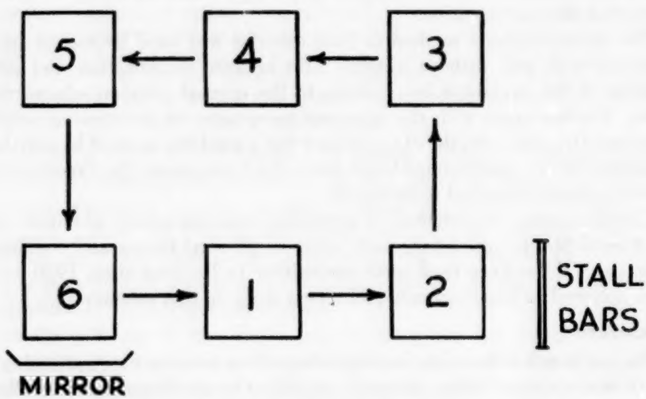

FIGURE I. Circuit of activities.

Program for Six-Week Experimental Period

Group A:	Monday	30 minutes swimming
	Wednesday	10 minutes swimming plus 15 minutes circuit training
	Friday	10 minutes swimming plus 15 minutes circuit training

Group B: Monday, Wednesday, Friday — 30 minutes swimming

The entire swimming program followed by both groups throughout the six-week period is included in Appendix A of the complete study.

Circuit Training Program

The circuit used in this study, consisted of six activities set out in a circular fashion around the perimeter of an adapted physical education room. The room was set out in the manner described so that the subjects could move around from one activity to another without confusion. The activities consisted of four in which weights were used, and two which did not use weights. The activities are listed below, together with the starting weights.

1. Two-arm curl—45-lb. barbell.
2. Bounce jumps with knee lift at stall bars.[3]
3. Bent-over rowing motion—55-lb. barbell.
4. Leg press—180-lb. barbell.
5. Two-arm press—50-lb. barbell.
6. Squat thrust.

The activities were set out in a circuit as shown in Figure I.

Three of the four activities using weights were devoted to upper body work and the fourth was a leg exercise. The amount of weight for each activity was arbitrarily determined but was such as to be within the range of the subjects. The two activities without weights were included to give vigorous, general exercise designed to promote efficiency of the circulatory and respiratory systems.

Procedure with Experimental Group

At the end of the first testing week, the groups were formed and the experimental group was given instruction in circuit training methods. Following a demonstration of the six activities and the method of progression around the circuit, the subjects practiced the activities and familiarized themselves with the procedure. After a rest, during which each subject was given a record and work sheet, the subjects completed one lap of the circuit, performing each activity at the maximum number of repetitions of which they were capable.

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[3] Initial position: The subject stands with feet together facing the stall bars and at arms-length from them. The hands are placed over-grasp on the bar immediately above eye-level and shoulder-width apart. Movement: Using pull from the arms and thrust from the legs, the subject jumps up to place his feet as close to his hands as possible. Without pause, he jumps down to the initial position landing on his toes, and then repeats the movement. This is a continuous movement with the hands maintaining a grasp on the stall bar during the repetitions.

The number of repetitions to be performed while completing three laps of the circuit, which was the full training session, was arbitrarily set at 66⅔ percent of the maximum repetitions. These numbers were calculated and recorded on the work sheets which were handed out to the subjects on the first day of the experimental period. The subject placed a check mark in the appropriate space each time he finished one set of repetitions and thus kept an accurate record of his progress around the circuit.

An added device to ensure maximum output of work and the application of the overload principle, was added in the form of a time limit. The three laps of the circuit had to be completed in 15 min. The effect of the time limit was to cause the subject to be working at his full capacity on the last lap (19).

The initial work load was used for the first two weeks and then progressive increases were made at intervals of two weeks, in accordance with the following schedule:

1. Weeks 1 and 2: Two-thirds of the maximum number of repetitions which the performer made on one circuit only.
2. Weeks 3 and 4: A. Activities without weights, numbered 2 and 6, increased by two repetitions. B. Same number of repetitions on activities with weights, numbered 1, 3, 4 and 5, but all weights increased by ten pounds.
3. Weeks 5 and 6: A. Activities numbered 2 and 6 increased by two repetitions. B. Same number of repetitions on activities numbered 1, 3, 4 and 5, all weights increased by ten pounds.

The circuit training method used in this experiment can be summarized as follows.

1. Three laps of the circuit, which included six activities, were made in 15 min.
2. Each activity was performed at 66⅔ percent of the maximum number of repetitions of which the subject was capable when completing one lap only.
3. The experimental group had two sessions of circuit training each week for six weeks.
4. The amount of weight or number of repetitions was progressively increased every two weeks.

Testing

During the initial week of testing, the order of tests was: Day I—15-min. endurance swim with number of lengths each subject swam recorded by assistants; Day II—speed swim for one length of pool, 33⅓ yds., and subjects measured for height and weight; Day III—strength tests consisting of chins, dips, push-ups, and vertical jump.

Statistical Treatment

The differences between the first and second tests for both experimental and control groups were used to compare the two groups. The difference which indicated the improvement or deterioration in the factors considered was calculated for each subject.

The means of the differences between the first and second tests, their significance, and standard deviations were compiled for both experimental and control groups for all factors. The experimental group was then compared with the control group using the critical ratios. Levels of confidence in the differences were obtained. Table 1 contains the arithmetic means of the factors tested. The means were computed from the difference columns of the tables of raw scores, with the exception of the mean age, which was based on the ages of the subjects in the first testing week. The mean scores for the experimental group were higher than the control group on all factors excepting endurance. The negative speed swim mean indicates a lowering of the mean time taken to swim one length by the experimental group and thus a faster performance. The positive mean for the control group shows a slower mean time.

The significance of the means were obtained to determine whether the means represented real differences between the first and second tests, or chance differences. The t scores obtained are presented in the columns "Significance of M_D" in Table I.

Analysis of the Data

1. The majority of the subjects in both groups improved or maintained their swimming endurance during the six-week training period. There were two cases in both groups where subjects showed a loss of swimming endurance.
2. The experimental group produced a significant increase in speed.
3. The control group did not increase in speed. Apart from one subject who made an unusually high increase, the increases in speed were counterbalanced by the decreases.
4. Both groups increased in weight, but the average amount of increase by the experimental group was four pounds more than the control group.
5. On all strength items, the experimental group made increases. Of these, the increases in ability to perform chins and push-ups were most significant.
6. The control group produced a small increase in ability to perform dips on parallel bars, but it was not significant.
7. The control group had a strong tendency to lose strength as shown by their reduced performance on the chins, vertical jump, and push-ups.
8. The experimental group had a high standard deviation for weight change which is accounted for by an increase of 13½ lbs. by subject 6 and a loss of 2 lbs. by subject 2.

TABLE I.—MEAN AGE AND MEANS OF THE DIFFERENCES BETWEEN THE 1ST AND 2ND TESTS AND THE SIGNIFICANCE OF THE MEANS OF THE DIFFERENCES

Group	Age Mean	Weight		Endurance Swim		Speed Swim		Chins		Dips		Vertical Jumps		Push-ups	
		Mean Difference M_D	Significance of M_D	Mean Difference M_D	Significance of M_D	Mean Difference M_D	Significance of M_D	Mean Difference M_D	Significance of M_D	Mean Difference M_D	Significance of M_D	Mean Difference M_D	Significance of M_D	Mean Difference M_D	Significance of M_D
Experimental	18.7	+5.54	3.96	+1.32	2.159	−0.68	2.142	+1.36	3.00	+1.00	1.312	+0.5	1.803	+3.27	2.125
Control	18.6	+1.36	2.99	+1.77	2.361	+0.16	0.545	−0.363	0.69	−0.63	0.718	−0.09	0.3163	−0.09	0.057

9. Both groups had relatively high variability in the endurance swim test. This was caused by the loss of ability demonstrated by two subjects in each group.

10. The wide range of variability in the dips for both groups resulted in high standard deviations for this factor. Scores ranged from + 6 to — 3 in both groups.

11. The high standard deviation in the experimental group for push-ups was caused by two negative scores and one very high positive score. However, in the control group the high standard deviation for this same factor was indicative of an even and wide spread.

Levels of Confidence

Table 1 contains the mean differences of the scores from the first to second tests for all factors, and for both groups. It also contains scores which represent the significance of the mean differences. They are t scores, and thus can be used to represent the level of confidence which can be placed in the differences. They are interpreted here to show whether or not the groups improved their performances as a result of their different training program.

1. The experimental group made significant gains in weight, endurance swim, speed swim, chins, and push-ups. The gains in weight and chins were significant at the 1 percent level of confidence. The other factors were significant at the 5 percent level of confidence.

2. The experimental group did not improve significantly in the dips or vertical jump.

3. The control group gained significantly in weight at the 1 percent level of confidence, and in the endurance swim at the 5 percent level of confidence.

4. The control group made no significant gains at the speed swim, chins, dips, vertical jumps, nor push-ups.

Levels of confidence were also established to determine whether or not the increases made by the experimental group were significantly greater than those made by the control group. The following interpretations for each factor given in Table 3 are based on an acceptance or rejection of the null hypothesis. The 5 percent level of confidence was accepted as representative of significant differences between the groups.

1. The experimental group made significantly greater gains in weight than the control group. The 4.48 percent level of confidence is within acceptable limits and thus the null hypothesis was rejected.

2. In the endurance swim there was no significant difference between the groups. Any gains or losses in performance were due solely to chance or accidental factors. The null hypothesis was accepted.

3. The two groups were found to be widely different in the speed swim. A high level of confidence indicated that the experimental group had made greater increases in speed than the control group. However, the level of confidence was 5.26 percent, which is slightly lower than the completely acceptable 5 percent level of confidence.

TABLE 2.—STANDARD DEVIATION OF THE MEANS OF THE DIFFERENCES BETWEEN THE FIRST AND SECOND TESTS

Group	Weight Change lbs. S.D.	Endurance Swim. No. Lengths S.D.	Speed Swim Seconds S.D.	Chins S.D.	Dips S.D.	Vertical Jump Inches S.D.	Push-Ups S.D.
Experimental	4.43	1.934	1.004	1.432	2.41	0.88	4.865
Control	1.44	2.371	0.9	1.663	2.774	0.9	4.962

TABLE 3.—CRITICAL RATIOS (t) OF THE DIFFERENCES BETWEEN THE EXPERIMENTAL GROUP AND THE CONTROL GROUP

Factor	Critical Ratio (t)	Level of Confidence
Weight Change	2.008	4.48
Endurance Swim	0.465	64.20
Speed Swim	1.939	5.26
Chins	2.483	1.32
Dips	0.3184	75.06
Vertical Jump	1.486	13.74
Push-Ups	1.530	12.60

4. The experimental group made significantly greater improvement in ability to do chins on a high bar when compared with the control group. The 1.32 percent level of confidence facilitated the rejection of the null hypothesis.

5. There was no significant difference between the groups in the ability to perform dips on the parallel bars. The null hypothesis was accepted.

6. In the vertical jump there was a tendency towards greater improvement by the experimental group but the level of confidence was too low, 13.74 percent, and the null hypothesis was accepted.

7. The push-ups test yielded similar results to the vertical jump test. The experimental group tended to have a greater improvement in performance but the level of confidence was too low, 12.60 percent, and the null hypothesis was accepted.

Summary

The purpose of this study was to determine the relationship between circuit training and the improvement of endurance, speed, and strength of swimmers. Changes in height and weight resulting from a training period of swimming and circuit training were also measured. A further purpose was to consider the feasibility of combining two 15-min. sessions of circuit training with a weekly swimming program, consisting of three 30-min. sessions, without detrimental effect on swimming improvement.

The 24 subjects for the study were members of an intermediate swimming class conducted for general college students at the University of California,

Los Angeles. They were given a 15-min. endurance swimming test to determine the number of lengths they could swim using the crawl stroke. On the basis of the test scores, the subjects were divided into two matched groups. During the study one subject dropped out of the class and another subject was ill during the last two weeks and did not participate in the final testing period. Fortunately, one of these subjects was originally in the experimental group and the other was in the control group.

In the initial testing period all subjects were tested in swimming speed, dips, chins, vertical jump, and push-ups, together with the endurance swimming test. Measurements were also taken for height and weight. One of the matched groups was randomly selected to be the experimental group and the other became the control group. The experimental group followed a six-week training program combining circuit training and swimming, while the control group had only swimming. At the end of the training program all subjects were retested on all items.

Conclusions

The following conclusions were derived from the findings of this study.

1. The experimental group made significant gains in swimming endurance and speed, weight, chins, and push-ups, but did not improve significantly in dips or vertical jump. There were no changes in height.

2. The control group made significant gains in swimming endurance and weight, but did not improve significantly in swimming speed, chins, dips, vertical jump, push-ups, or height.

3. The control group had a marked tendency to lose strength. It was not a significant loss but each subject deteriorated in performance on at least one strength test. Six of the subjects lost strength on two or more tests.

4. The experimental group made significantly greater gains than the control group in weight and chins. An increase in swimming speed by the experimental group was significantly greater than the control group mean difference at the 5.26 level of confidence.

5. There were no significant differences between the groups in swimming endurance, dips, vertical jump, or push-ups.

6. This evidence appears to justify the generalization that it is possible to combine a circuit training program with a swimming program without detrimental effect on swimming improvement. Furthermore, the gains in swimming endurance and speed made by the experimental group suggest that this combination is beneficial.

7. The findings of this study support the evidence of previous studies reported in the RESEARCH QUARTERLY (4, 5, 8, 13, 15, 24, 25) concerning progressive resistance exercises. There was no significant evidence to show that weight training was in any way detrimental to athletic performance. On the contrary, subjects using weight training, as part of circuit training, increased their ability in swimming endurance and speed, chins, and push-ups.

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(Submitted 10/26/59)

A Study of the Performance of Boys and Girls Taught by the Specialist and the Nonspecialist[1]

BERTHA M. ROSS
Public Schools
Rockford, Illinois

Abstract

A study was made of 240 fifth and sixth grade boys and girls in the Rockford, Illinois, elementary schools to compare the performance scores of those taught by the specialist in physical education with those taught by the nonspecialist. The Iowa Brace, the short potato race, the 30-yard dash, and the standing broad jump were the tests used to make the comparison. A split-plot analysis of variance was used to investigate differences, if any, in performance scores. The over-all analysis showed superior performance by specialist-taught pupils on the 30-yard dash only; boys superior to girls in all events; the sixth grade superior to the fifth grade on the standing broad jump and the 30-yard dash. Other differences were noted when the specialist and nonspecialist groups were analyzed separately.

THERE IS CONSIDERABLE controversy among educational authorities concerning the merits of the self-contained classroom versus the use of special teachers in art, music, and physical education. Many authorities in the field of physical education believe that teachers of physical education in the elementary schools should be persons trained and certified to teach physical education activities.

There is, for example, evidence of a decided difference of opinions between classroom teachers and supervisors of physical education about the capabilities and preparation of the former to adequately handle physical education activities. Baker, Annis, and Bontz (1, 2) indicated that classroom teachers felt adequately prepared while the supervisors did not agree. This difference of opinion was found in team games, background in special methods, analysis of skill, program planning, and dance and rhythm.

Nevertheless, the trend in education today seems to be toward the self-contained classroom. In 1940, Georgiady and Savage (4) found that 37.8 percent of elementary physical education programs were organized by the classroom teacher. In 1952, Baker, Annis, and Bontz (1) found in a survey

[1] This is a summary of a problem presented to the faculty of the Department of Physical Education for Women, University of Wisconsin, in partial fulfillment of the requirements for the degree Master of Science. The author wishes to thank G. Lawrence Rarick for his advice and guidance throughout the author's graduate work and Frances Z. Cumbee, counselor, School of Education, for her generous expert advice in the application of the analysis of variance.

of good schools that 55 percent of programs were carried on by the classroom teacher. However, experimental evidence to uphold the desirability of this practice is limited.

After the present study was completed, a report by Zimmerman (8) indicated that girls having special teachers were better in 14 of 35 events (boys 20) than girls and boys taught by classroom teachers. However, it should be pointed out that the "special" teachers referred to in the Zimmerman study are former classroom teachers who took over teaching physical education; those "specialists" were not professionally trained physical educators.

It would seem that studies are needed that give evidence to support or refute the existence of superior motor performance by pupils after they have been taught by a person professionally trained in physical education. It is for this reason that the study reported here was undertaken. This study is being reported since it may lead to improved designs that will help in solving the controversy.

Purpose

The purpose of this study was to compare the motor performance scores of fifth and sixth grade boys and girls receiving physical education instruction from the specialist, or trained teacher, with the performance scores of fifth and sixth grade boys and girls taught by the nonspecialist.

Procedure

Selection of the Sample. Schools were chosen at random from the elementary school population of Rockford, Illinois. There are 24 schools in this system with grades one through six. Eleven schools have classroom teachers teaching physical education and 13 schools have teachers with professional preparation in physical education. It was decided to choose, at random, six schools from the 11 classroom teacher schools and six from the 13 provided with trained teachers. Five boys and five girls were selected at random from the fifth grade and the same number from the sixth grade in each of the 12 schools, making a total of 240 children—120 from the classroom teacher schools and 120 from the special teacher schools. The children selected were restricted to those in attendance in the Rockford, Illinois, schools from grade one through grades five and six. In the nonspecialist schools the selections were restricted to children who had not received instruction in physical education from a trained teacher. In the specialist schools, the selections were restricted to children who had trained physical education teachers from grade four through grade six.

Tests. The following tests were used in this investigation: the Iowa Brace, the 30-yard dash, the short potato race, and the standing broad jump. Other tests could have been included, but after consideration of playground facilities and time required to administer the tests, and consultation with the major professor, it was decided that the items selected could help clarify some of the problems for future studies. Three trials were given on the standing broad

jump and two trials on the 30-yard dash and the short potato race. The Iowa Brace was administered as outlined by McCloy (6). All tests were administered within a period of one week during May 1957. This was near the end of the school year. One half day was spent at each school during the school day in all instances except in two schools, where the tests were given on a Saturday morning. The writer gave all directions and demonstrations. An assistant, competent in the field of physical education and familiar with the testing procedures, recorded all scores with the exception of the Iowa Brace where paired individuals checked one another.

Statistical Treatment. The Pearson product moment method of correlation was used to determine the consistency between trials on the standing broad jump, the short potato race, and the 30-yard dash. For the standing broad jump the best trial was correlated with the average of the other two. For the short potato race and the 30-yard dash, the first trial was correlated with the second trial. Since the Iowa Brace is reported as a total score, and since only one test was given, no correlation could be computed. Administering all tests a second time to 240 students in order that test-retest reliability could be determined seemd too time consuming. Hence, it was decided to use the within-day consistency estimate of reliability.

One assumption in the use of the analysis of variance is homogeneity of variance. The variance for each of the 48 subsamples was calculated and Hartley's F-maximum ratio (7) was applied. Since none of the variance ratios were larger than would be expected by chance it was concluded that for these data there was homogeneity of variance.

A split-plot analysis of variance (3) was then applied to check for significant differences and interactions. Since there were no significant interactions that involved schools when the analysis was run on each plot, these interactions were pooled and used for the error term in the over-all analysis.

Discussion

The within-day consistency estimates of reliability for boys were .80, .45, and .66 on the standing broad jump, short potato race, and 30-yard dash respectively, while for girls they were .90, .55, and .69. However, as reported here, the estimates were indications of the consistency from trial to trial within one administration of the test, rather than estimates of reliability computed by comparing "the best" or "the sums of trials" on tests given at two different times. This may account for some of the estimates being lower than those reported in other investigations on the same tests. Moreover, the coefficient seemed to be sufficiently high to permit use of these measures for group analysis.

Table 1 will be used to discuss the analysis of variance. Referring first to the plot that summarizes the specialist-taught pupils, one may see that there was a significant grade difference (5% level) on only one event, the 30-yard dash. There was also a significant difference (5% level) between schools in this specialist-taught group. This is the only instance in which the main

TABLE 1.—SUMMARY OF THE ANALYSIS OF VARIANCE

Split-Plot Analysis

	Source of Variation	df	Iowa Brace Test SS	MS	F
SPECIALIST	Grade x Sex x School	5	166.842	33.368	2.250
	Grade x School	5	123.175	24.635	1.661
	Sex x School	5	83.841	16.768	1.131
	Grade x Sex	1	20.008	20.008	.600
	Grade	1	.675	.675	.027
	Sex	1	66.008	66.008	3.937
	School	5	33.642	6.728	.454
	Residual Within Cells	96	1423.609	14.829	
	TOTAL	119	1917.800		
NONSPECIALIST	Grade x Sex x School	5	128.667	25.733	1.762
	Grade x School	5	35.767	7.153	.490
	Sex x School	5	71.767	14.353	.983
	Grade x Sex	1	8.533	8.533	.332
	Grade	1	28.033	28.033	3.919
	Sex	1	149.633	149.633	10.425[a]
	School	5	77.467	15.493	1.061
	Residual Within Cells	96	1402.000	14.604	
	TOTAL	119	1901.867		
	Over-All Analysis				
	Method x Grade x Sex	1	1.204	1.204	.059
	Method x Grade	1	18.704	18.704	.920
	Method x Sex	1	8.438	8.438	.415
	Grade x Sex	1	27.337	27.337	1.344
	Method	1	.338	.338	.017
	Grade	1	10.004	10.004	.492
	Sex	1	207.204	207.204	10.190[b]
	Residual Within Cells	192	3435.661	17.894	
	Pooled Interactions	30	610.059	20.335	
	Within Type Instruction	10	111.109	....	
	TOTAL	239	4430.059		

[a] Significant at 5 percent level.
[b] Significant at 1 percent level.

variable, school, was found to be significant. Such a difference could be the result of a difference between teachers within the specialist schools, a difference between the socioeconomic background of students attending the specialist schools, a difference in performance skills, or a combination of these. This study was not concerned with differences between the specialist schools or specialist teachers but with the difference in performance of boys and girls who were taught by the specialist and the nonspecialist. No further mention of this will be made throughout the study.

TABLE 1 CONTINUED

Thirty-Yard Dash			Short Potato Race			Standing Broad Jump		
SS	MS	F	SS	MS	F	SS	MS	F
.432	.087	.810	1.185	.237	.635	430.375	86.075	.725
.406	.081	.760	1.619	.324	.869	965.175	193.035	1.625
.814	.163	1.525	.569	.114	.306	120.642	24.128	.203
.000	.000	.001	.252	.252	.923	27.075	27.075	.315
.631	.631	7.768^{a}	1.519	1.519	4.668	357.075	357.075	1.850
.574	.574	3.561	.169	.169	1.482	37.408	37.408	1.550
1.496	.299	2.802^{a}	4.035	.807	2.164	974.242	194.849	1.640
10.256	.107		35.800	.373		11404.008	118.792	
14.610			45.148			14316.000		
1.499	.299	2.243	1.935	.387	.956	883.175	176.635	1.203
.323	.064	.483	.685	.137	.338	265.575	53.115	.362
.791	.158	1.183	1.135	.227	.561	122.775	24.555	.167
.001	.001	.004	.602	.602	1.556	126.075	126.075	.714
1.633	1.633	25.322^{b}	2.552	2.552	18.628^{b}	27.075	27.075	.510
1.121	1.121	7.092^{a}	4.602	4.602	20.273^{b}	1248.075	1248.075	50.827^{b}
.875	.175	1.309	2.085	.417	1.030	317.242	63.448	.432
12.830	.134		38.900	.405		14094.008	146.813	
19.163			52.496			17084.000		
.001	.001	.007	.817	.817	3.437	18.150	18.150	.195
.117	.117	.823	.067	.067	.281	93.750	93.750	1.009
.045	.045	.319	1.504	1.504	6.331^{a}	426.660	426.660	4.591^{a}
.000	.000	.003	.038	.038	.158	135.000	135.000	1.453
1.998	1.998	14.053^{b}	.004	.004	.018	326.670	326.670	3.515
2.147	2.147	15.098^{b}	4.004	4.004	16.853^{b}	290.400	290.400	3.125
1.650	1.650	11.603^{b}	3.267	3.267	13.749^{b}	858.820	858.820	9.242^{b}
27.349	.142		81.830	.426		28285.723	147.321	
4.265	.142		7.128	.238		2787.720	92.920	
2.371	———		6.120	———		1291.484	———	
39.943			104.779			34514.380		

It is interesting that there were no sex differences in this specialist group. One usually expects, at this age level, to find boys superior in performance to girls.

In the nonspecialist group there were more differences found. There was a sex difference in all events; a difference at the 5 percent level on the Iowa Brace and the 30-yard dash, and a difference at the 1 percent level on the short potato race and the standing broad jump. There was also a grade difference at the 1 percent level on the short potato race and the 30-yard

dash. Both of these tests are measures of some type of speed, a quality which seems more easily measured by time in seconds by a stopwatch.

In the over-all analysis,[2] there were significant differences in performance by sex for all four events at the 1 percent level. Table 2 shows that the boys were superior to the girls in all events. Such a result is to be expected since it is generally accepted that boys at this age level are superior to girls in performance. It is also possible that the events were more appealing to boys than to girls, so that the boys practiced more and put forth more effort.

TABLE 2.—COMPARISON OF MEANS OF VARIOUS SCORES

	Iowa Brace	Short Potato	Thirty-Yard Dash	Standing Broad Jump
Sex: Boys	10.72[a]	5.69[a]	4.50[a]	55.22[a]
Girls	8.90	5.45	4.68	51.43
Grade: Fifth		5.45	4.69	
Sixth		5.70[a]	4.46[a]	
Method: Specialist			4.50[a]	
Nonspecialist			4.70	

[a] Denotes best performance means.

Attention is called again to the sex differences noted in the split-plot analysis. There was no significant sex difference in any event for the specialist group and a difference on all events for the nonspecialist group. The discrepancy in differences when the specialist and nonspecialist groups were considered separately is not readily apparent. Perhaps the specialist is able to instruct girls in such a way that their motor performance is more nearly at the level of performance of boys. Such an hypothesis needs further investigation.

Also, in the over-all analysis it may be noted that there was a grade difference in the short potato race and the 30-yard dash at the 1 percent level. Table 2 shows that the sixth grade had the better performance on both levels. This seems reasonable in that sixth graders would be better acquainted and more experienced in the skills used to execute these events. The Iowa Brace and the standing broad jump are events that probably would be practiced by boys more than girls, hence increasing performance level from grade to grade.

A main question to be answered in this investigation was whether pupils taught by the specialist were superior in motor performance to pupils taught by the nonspecialist. It is interesting to note a difference in the specialist-

[2] The reader may note in Table 1 a source of variation, "Within type instruction," set apart by lines in the over-all analysis. The figures given for this source of variation are neither complete nor to be used, since instructors in schools, chosen when the school was chosen, could not interact with the other sources of variation. As a result, this small portion of the over-all analysis is nonorthogonal, introducing a slight discrepancy between the total over-all sums of squares and the sum of the totals of the sums of squares in the split-plot analysis.

taught and the nonspecialist-taught only on the 30-yard dash, the specialist group having the better performance. Such a result might suggest that instruction in the 30-yard dash under the specialist is more effective than instruction given by the nonspecialist, or that the specialist, because of interest, stressed the fundamentals of running more than the nonspecialist.

The fact that the other events used in this study show no significant difference between the specialist group and the nonspecialist group could have been the result of several factors. One may be that all activities in Rockford elementary schools, whether taught by the specialist or by the nonspecialist, are under the direction of a supervisor of physical education and all schools follow the same program of activities in grades one through six. In addition, there is an assistant to the supervisor of physical education who is available to give instruction and demonstrations of the fundamentals in the major units of activities in the nonspecialist schools. Moreover, the same testing program is given in the upper grades in all schools; the standing broad jump, the potato race, and the 30-50 yard dash are included along with others. Demonstrations of methods of teaching various fundamental skills also are given by the specialist to the nonspecialist. Another reason which may account for the absence of more differences is that pupils in the Rockford elementary schools are exposed to the special teacher in physical education beginning at the fourth grade level. Perhaps a longer period of time, from grade one through all grades, under the guidance of a specialist might result in better performance on the part of pupils. All such possibilities, however, need further study.

Two other reasons may be significant. First, the random selection of schools and then individuals, as in this study, reduces the power of the error term, thus making the test less sensitive. Second, the beginning skill levels of students under the specialist and nonspecialist might have been different. Since students were not tested at the beginning of the school year, it was impossible to take this factor into consideration. Future studies, however, would be greatly improved if beginning skill levels were taken into consideration, and covariances used in treating the data.

Table 1 indicates a significant interaction between method and sex on the short potato race and the standing broad jump. An analysis of residuals from these two significant interactions indicated that girls were superior in performance when under the instruction of a specialist and the boys were superior in performance when under the instruction of a nonspecialist. An explanation for this significant interaction does not seem immediately apparent. It could be that boys at this age are more daring and practice the activities outside of class. Perhaps the outside practice results in near peak performance for all boys, so that the aid of the specialist does not result in a better performance. Girls, on the other hand, are influenced more by the specialist since they probably practice these activities only in class. Further investigations are needed to determine the effect of sex of the teacher on performance of boys and girls.

Findings

Within the limitations of this study, the following findings are reported:

1. Boys and girls taught by the specialist had significantly better performance scores on the 30-yard dash than those taught by the nonspecialists. There was no difference between the two groups on the Iowa Brace, the short potato race, and the standing broad jump.
2. Sixth grade boys and girls performed better than the fifth grade boys and girls on the short potato race and the 30-yard dash. There was no difference between grades in performance on the Iowa Brace and the standing broad jump.
3. For the combined groups, specialist and nonspecialist, boys were superior to the girls in performance in all events. The same may be said for the group of boys and girls under nonspecialist; but for boys and girls under the specialist, there was superior performance by the boys only on the 30-yard dash.
4. There were significant interactions between method and sex on the standing broad jump and the short potato race. An analysis of the residuals suggested that girls taught by the specialists were superior in performance to girls taught by the nonspecialist, while boys taught by the nonspecialists were superior in performance to boys taught by the specialists.

Recommendations

1. Future studies investigating the problem should be designed in such a way that:
   a. All subjects are drawn at random from the specialist population and the nonspecialist population of children rather than randomly selecting schools, then children. Such a procedure would permit the use of an error term with more power.
   b. An analysis of covariance be used in order that the difference in skill level at the beginning of instruction be taken into account.
2. With the above refinement in design taken into consideration, other studies should be done:
   a. For grade levels other than those included in this study.
   b. With similar age groups but include a wider variety of variables that are simple in purpose and in measurability.
   c. In schools where the specialist and the nonspecialist are not under the same supervisor and do not necessarily follow the same guided program in physical education.
   d. With consideration given to the amount of training of the specialist, the number of years of teaching experience of the specialist, and the sex of the specialist.
   e. In a school system where there are schools with a specialist from grades one through six and schools with specialist only from grade four through six. The study could then be designed to explore the effect of more years of training on the performance of fifth and sixth graders.

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(Submitted 3/1/59)

Follow-up Study on Simplification of the Strength and Physical Fitness Indexes

EMERY W. SEYMOUR
Springfield College
Springfield, Massachusetts

Abstract

This study attempted to substantiate the findings of Clarke and Carter in Oregon concerning simplification of the strength and physical fitness indexes. Test results of 316 Massachusetts senior high school boys were compared with the Oregon data. The Massachusetts results were almost identical with the original data and likewise indicated the possibility of reduction of test items with virtually no loss of accuracy. Additional examination of the Massachusetts data indicated that 15, 16, and 17 year old boys could be included in a single category of senior high school and did not require treatment by individual age.

IN THE RESEARCH QUARTERLY of March 1959, Clark and Carter (2) described their efforts to produce a simplification of the Physical Fitness Index battery of test items for boys of the upper elementary school, junior high school, and senior high school levels. Utilizing data obtained from the testing of 356 boys in the Medford, Oregon, public schools, the authors calculated multiple correlations with the Strength Index and with the Physical Fitness Index at each of the three school levels with a reduced number of test items. All multiple correlations with the Strength Index were .977 or higher, and this prompted the computation of multiple regression equations for the approximation of a boys' Strength Index while eliminating some of the test items. The authors concluded:

> Obviously, the simplified versions do not require as many pieces of testing apparatus as does the full test, although a back and leg dynamometer is still necessary. Also, the simplification can be given more rapidly and with fewer testers than the complete test.

Many physical educators consider the PFI a valuable indicator of a student's fitness level but feel unable to administer it in their situations because of the expense connected with the necessary apparatus and the demands of time and personnel. Therefore, the findings of Clarke and Carter seemed to offer valuable information to the profession.

Two basic questions occurred to this investigator in reviewing the above article. The first pertained to the source of the data. Since only Medford, Oregon, boys were used as subjects, it might be desirable to know if their data were representative of boys elsewhere. Additionally, the size of the sample provided a possible limitation since there were only 40 boys at each of the ages tested (9 through 17) except the 17-year-olds, of whom there were 36.

Although the Oregon study dealt with boys of all three school levels, this investigator used only the senior high school group in his follow-up study of the findings of Clarke and Carter. There were 316 boys included in the study and they were students at Longmeadow, Massachusetts, High School and Amherst, Massachusetts, Regional High School. There were 101 15-year-olds, 121 16-year-olds, and 94 17-year-olds. Clarke and Carter had included all the boys of each school level in a single grouping for purposes of statistical treatment. In the Massachusetts study, the data were treated as a composite of senior high school boys and also were handled separately for individual years in an effort to determine whether a single regression equation would satisfy or if equations for each age would provide more accurate estimations.

The procedure for testing was identical with that used in Oregon. The testing techniques were those described in Clarke's book (1). The administration of the tests was done by professional students enrolled in the course in tests and measurements who had been thoroughly trained. Supervision was provided at all times by qualified faculty members of the School of Physical Education of Springfield College. The results of the testing corresponded closely with those reported by Clarke and Carter. The Massachusetts mean was 105 as compared to a mean PFI of 108 for the Oregon senior high school boys.

Treatment of Data

In order to compare data from the two studies, the same methods of analysis used on the Oregon data were employed on the Massachusetts results. The initial step was the calculation of product-moment correlations of the test items with both the Strength Index and the Physical Fitness Index. Also, the various intercorrelations among the test items were determined. The author did not, however, calculate arm strength by the McCloy formula. Clarke and Carter did not utilize this in their regression formulas, and it was omitted in treating the Massachusetts data. Table 1 shows how the correlations and intercorrelations compare in the two studies. The first figure represents results obtained by the author. The figures in parentheses indicate correlations and intercorrelations from the Oregon data for the corresponding relationships among senior high school boys.

The authors of the Oregon study made a number of observations concerning various relationships. The same situations existed among the Massachusetts high school boys in the following instances.

1. In both studies, the highest intercorrelation was with Rogers arm strength and push-ups, .85 (.86). Pull-ups and arm strength intercorrelations were somewhat lower, .74 (.69).

2. Intercorrelations between the two grip strength scores were .67 (.72). Both grips had rather high intercorrelations (.48 or better) with back lift, leg lift, and lung capacity in each study.

TABLE 1.—INTERCORRELATIONS OF TEST ITEMS AND THEIR CORRELATIONS WITH THE STRENGTH INDEX AND THE PHYSICAL FITNESS INDEX FOR SENIOR HIGH SCHOOL BOYS

Test Items	Left Grip	Back Lift	Leg Lift	Lung Capacity	Pull-ups	Push-ups	Arm Strength	Strength Index	Physical Fitness Index
Right grip	.67 (.72)	.48 (.60)	.51 (.61)	.53 (.64)	.18 (.11)	.23 (.27)	.44 (.51)	.64 (.73)	.24 (.13)
Left grip		.52 (.53)	.52 (.55)	.48 (.57)	.12 (.13)	.25 (.30)	.42 (.51)	.64 (.68)	.23 (.14)
Back lift			.57 (.51)	.45 (.53)	.17 (.19)	.26 (.33)	.38 (.51)	.70 (.74)	.38 (.20)
Leg lift				.45 (.54)	.17 (.10)	.30 (.25)	.44 (.46)	.91 (.90)	.52 (.41)
Lung capacity					—.04 (—.01)	.04 (.11)	.30 (.36)	.56 (.64)	.01 (.01)
Pull-ups						.69 (.63)	.74 (.69)	.42 (.34)	.72 (.66)
Push-ups							.85 (.86)	.56 (.53)	.72 (.70)
Arm strength								.74 (.77)	.61 (.65)

First figures represent Massachusetts data.
Figures in parentheses are Oregon data.

3. Pull-ups and push-ups showed very significant relationships in each instance, i.e., .69 (.63). With the other test items, the pull-ups and push-ups showed slight relationship (none more than .33).

4. The highest correlation between a test item and the Strength Index was obtained with the leg lift, .91 (.90). High correlations were also obtained with arm strength, .74 (.77), with back lift, .70 (.74), with right grip, .64 (.73), and with left grip, .64 (.68).

5. With a criterion of the Physical Fitness Index, push-ups had the highest correlations, .72 (.70), followed in order by pull-ups, .72 (.66), arm strength, .61 (.65), and leg lift, .52 (.41).

Thus, it may be seen that the same general relationships existed among the test items and the criteria for the two groups of subjects located on opposite borders of the nation.

Multiple Correlations

The multiple correlations obtained with the Strength Index and the Physical Fitness Index as the criterion measures were as follows:

Criterion		*R.*	*Independent Variables*
PFI	Mass.	.851	Push-ups, pull-ups, leg lift
	Mass.	.796	Push-ups, pull-ups, leg lift
SI	Mass.	.983	Leg lift, Rogers arm strength score
	Oregon	.985	Leg lift, Rogers arm strength score
SI	Oregon	.997	Leg lift, Rogers arm strength, back lift
	Oregon	.996	Leg lift, Rogers arm strength, back lift

The following statements, made by Clarke and Carter, were substantiated by the Massachusetts data. "The multiple correlations with the SI as the criterion were found to be higher . . . than when the PFI was the dependent variable . . . In general, pull-ups and push-ups correlated better with the PFI than did the other tests; the Rogers arm strength score was an important variable in the SI multiple correlations."

Multiple Regression Equations

Following the example of the Oregon study, the author also computed two multiple regression equations with the Strength Index as the criterion. The items were the same as those reported in the earlier study; i.e., leg lift and arm strength which provides for maximum testing economy, or leg lift, arm strength, and back lift which more nearly approximates the score obtained from the entire battery.

The multiple regression equations follow with the Oregon equations underneath in brackets.

$$\text{A: } R = .983$$
$$SI = 1.23\ (\text{leg lift}) + 1.14\ (\text{arm strength}) + 530$$
$$S.E._{est} = 96$$
$$(\text{A: } R = .985)$$
$$SI = 1.22\ (\text{leg lift}) + 1.23\ (\text{arm strength}) + 499$$
$$S.E._{est} = 86$$
$$\text{B: } R = .997$$
$$SI = 1.06\ (\text{leg lift}) + 1.06\ (\text{arm strength}) + 1.20\ (\text{back lift}) + 290 \quad S.E._{est} = 39$$
$$(\text{B: } R = .996)$$
$$SI = 1.07\ (\text{leg lift}) + 1.06\ (\text{arm strength}) + 1.42\ (\text{back lift}) + 194 \quad S.E._{est} = 44$$

The equations of both studies are very similar, and in each case the approximation of the actual SI is considerably more accurate when the B equation is employed. For the Massachusetts data, the standard error of estimate is about 2.5 times greater for the A equation; for the Oregon data, the error in A is almost twice that of B.

In the same manner that Clarke and Carter checked their predicted PFI's against actual scores, the author employed both formulas to get predicted SI's and thus PFI's. Table 2, which is in the same form as that used in the earlier study, shows the results of both studies.

The maximum difference between predicted and actual PFI means with the four equations for high school boys was 1.0 PFI points and the larger mean difference for the Massachusetts study was only .4 PFI points.

Analysis of Data by Individual Years

Because of the hypothesis that correlations or regression equations which treated boys of ages 15, 16, and 17 as a composite group might not give as accurate a picture of these subjects as might be obtained through analysis of each age separately, the author treated the data by individual years. As mentioned earlier, there were 101, 121, and 94 boys of ages 15, 16, and 17, respectively. Table 3 gives the correlations with the criteria and the test item intercorrelations for each level. The observations given earlier for the composite group apply generally to the relationships which exist within separate age groups.

TABLE 2.—COMPARISON OF ACTUAL AND PREDICTED PHYSICAL FITNESS INDEXES FOR SENIOR HIGH SCHOOL BOYS

Equation	Means Actual	Means Predicted	Mean Diff.	Standard Deviation of Differences
A	104.6	104.5	— .1	2.7
	(108.2)	(109.9)	(+ .7) (*sic*)	(4.6)
B	104.6	104.2	— .4	1.5
	(108.2)	(109.2)	(+1.0)	(3.1)

Figures in parentheses refer to Oregon data; others are for Massachusetts data.

TABLE 3.—INTERCORRELATIONS OF TEST ITEMS AND THEIR CORRELATIONS WITH THE STRENGTH INDEX AND THE PHYSICAL FITNESS INDEX FOR SENIOR HIGH SCHOOL BOYS, AGES 15, 16, AND 17

Test Items	Left Grip	Back Lift	Leg Lift	Lung Capacity	Pull-ups	Push-ups	Arm Strength	SI	PFI
Right Grip									
15 yrs.	.70	.53	.56	.54	.21	.18	.46	.66	.36
16 yrs.	.60	.35	.37	.46	.03	.02	.23	.54	.16
17 yrs.	.61	.36	.36	.43	.25	.30	.44	.55	.32
Left Grip									
15 yrs.		.57	.52	.50	.21	.26	.49	.65	.28
16 yrs.		.48	.40	.42	—.02	.02	.22	.49	.11
17 yrs.		.39	.51	.38	.16	.29	.41	.62	.31
Back Lift									
15 yrs.			.61	.51	.11	.08	.36	.68	.36
16 yrs.			.50	.29	.01	.08	.34	.61	.33
17 yrs.			.46	.39	.30	.31	.42	.66	.44
Leg Lift									
15 yrs.				.49	.19	.31	.48	.91	.50
16 yrs.				.31	.15	.23	.32	.90	.54
17 yrs.				.41	.14	.24	.35	.86	.50
Lung Capacity									
15 yrs.					—.05	—.01	.32	.58	—.01
16 yrs.					—.22	—.23	.06	.36	—.11
17 yrs.					—.03	.10	.30	.55	.13
Pull-ups									
15 yrs.						.72	.76	.42	.71
16 yrs.						.71	.76	.35	.68
17 yrs.						.72	.74	.46	.76
Push-ups									
15 yrs.							.89	.57	.78
16 yrs.							.82	.45	.72
17 yrs.							.89	.59	.75
Arm Strength									
15 yrs.								.75	.68
16 yrs.								.62	.65
17 yrs.								.74	.68

Multiple correlations were calculated for each of the age classifications and, as with the total group, one multiple correlation was obtained for each group where the PFI was the criterion and two for the SI as the criterion measure. These correlations are shown below.

Age Group	*Criterion*	*R*	*Independent Variables*
15-year-olds	PFI	.839	Push-ups, back lift, and leg lift
	SI	.973	Leg lift and arm strength
	SI	.986	Leg lift, arm strength, and back lift
16-year-olds	PFI	.849	Push-ups, leg lift, and pull-ups
	SI	.967	Leg lift and arm strength
	SI	.983	Leg lift, arm strength, and right grip
17-year-olds	PFI	.880	Pull-ups, leg lift, and push-ups
	SI	.978	Leg lift and arm strength
	SI	.990	Leg lift, arm strength, and back lift

Using the PFI as the criterion, push-ups and leg lift appear in each correlation. In two instances, pull-ups are the third variable while back lift is present on one occasion. With the SI as the criterion, the short or A correlation includes the leg lift and arm strength for all ages. Where a third variable is added, it is the back lift for the 15- and 17-year-olds and the right grip for the 16-year-olds. In the latter case, the contribution of the right grip is but slightly larger than that of the back lift.

All multiple correlations where the SI was the criterion were .967 or more and justified the calculation of regression equations. As with the composite group, two equations were formulated for each age group with the same relative advantages and disadvantages for the longer and shorter forms. The equations obtained were the following:

15-year-old boys

A: $R = .973$

$$SI = 1.22\ (\text{leg lift}) + 1.10\ (\text{arm strength}) + 519 \quad S.E._{est} = 104$$

B: $R = .986$

$$SI = 1.07\ (\text{leg lift}) + 1.06\ (\text{arm strength}) + .98\ (\text{back lift}) + 337 \quad S.E._{est} = 70$$

16-year-old boys

A: $R = .967$

$$SI = 1.22\ (\text{leg lift}) + .97\ (\text{arm strength}) + 607 \quad S.E._{est} = 116$$

B: $R = .983$

$$SI = 1.12\ (\text{leg lift}) + .91\ (\text{arm strength} + 5.41\ (\text{right grip}) + 197 \quad S.E._{est} = 83$$

17-year-old boys

A: R = .978

$$SI = 1.21\ (\text{leg lift}) + 1.22\ (\text{arm strength}) + 545 \quad S.E._{est} = 107$$

B: R = .990

$$SI = 1.09\ (\text{leg lift}) + 1.08\ (\text{arm strength}) + 1.06\ (\text{back lift}) + 314 \quad S.E._{est} = 72$$

In order to determine whether these individual equations could predict more accurately than the composite equation, predicted SI's were obtained and converted to predicted PFI's. Table 4 indicates the results obtained in this manner.

TABLE 4.—COMPARISON OF ACTUAL AND PREDICTED PHYSICAL FITNESS INDEXES FOR SENIOR HIGH SCHOOL BOYS, AGES 15, 16, AND 17

Age	Equation	Means Actual	Means Predicted	Mean Diff.	Standard Deviation of Differences
15	15-A	103.68	103.08	− .60	2.84
	Comp. A	103.68	104.83	+1.15	3.05
	15-B	103.68	102.78	− .90	1.55
	Comp. B	103.68	103.65	− .03	1.40
16	16-A	104.40	103.91	− .49	2.69
	Comp. A	104.40	104.34	− .06	2.60
	16-B	104.40	104.80	+ .40	2.54
	Comp. B	104.40	104.12	− .28	1.64
17	17-A	105.94	105.69	− .25	2.33
	Comp. A	105.94	104.32	−1.62	2.48
	17-B	105.94	105.48	− .46	1.30
	Comp. B	105.94	105.00	− .94	1.32

Examination of Table 4 fails to indicate a superiority in the predictive value of regression equations for specific ages. In fact, where the B or more accurate equation is employed, the mean difference between actual and predicted means is less in two of the three ages through the use of the composite formula. If the A equation is employed, the individual yearly equation gives a closer approximation in two of the three ages. Similarly, variability as indicated by the standard deviation of the differences between actual and predicted scores runs somewhat smaller with the composite equation when using equation B than is the case with the individual yearly equations. Again, though, if equation A is used, the situation is reversed and the composite equation produces slightly larger variability.

Conclusion

From the Massachusetts follow-up study of the work initiated in Oregon it may be concluded that the findings of the latter, at least as they relate to senior high school boys, have more than local application. Both studies obtained results which were almost identical in nature. Thus, greater assurance

is provided that reduction in test items may satisfactorily be introduced in the PFI testing of high school boys without loss of appreciable accuracy in results. As has been pointed out by Clarke and Carter previously, if this finding receives general recognition, PFI testing may be done more economically, in a shorter period of time, and with an appreciable decrease in the number of required testing personnel.

The analysis of data by individual years would seem to indicate that at the senior high school level at least such a breakdown is unnecessary. Treating boys of ages 15, 16, and 17 as a single senior high school group is a statistically defensible procedure and one which is strongly desirable from the standpoint of ease of scoring.

References

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(Submitted 10/2/59)

Reliability, Accuracy, and Refractoriness of a Transit Reaction

A. T. SLATER-HAMMEL
Indiana University
Bloomington, Indiana

Abstract

Two experiments were conducted to obtain further information on transit reactions. Analysis of results revealed that: (1) Test-retest reliabilities were high enough (.95-.84) to suggest passable reliabilities for transit measures; (2) the absolute error for performance with knowledge of results was significantly smaller than that for performance without knowledge of results; (3) performance with and without knowledge of results was remarkably free of systematic biases; (4) the introduction of catch trials increased the absolute and constant errors; and (5) the estimated threshold refractory period was 166 msec.

ONE LONG RECOGNIZED characteristic of human sensory-response systems is that they require time. It takes time for a stimulus to activate a sense organ; it takes time for neural impulses to pass along afferent neurons, through the central nervous system, and down efferent neurons; and it takes time for a response organ to initiate its action. At the reflex level these time delays may be extremely short, frequently no longer than 10-100 msec. For voluntary responses the delays may range from 150 to 300 or more msec.

While these built-in delays would seem to make it impossible for man to keep up with the present, such is not always the case. Man can, and frequently does, anticipate; he uses his experience of the past and he extrapolates from the immediate present so that he can meet the present-to-be. A driver will avoid an accident because he anticipates the movement of another car. A sprinter will make a fast start because he anticipates the firing of the pistol. And a batter will hit the ball because he is able to anticipate both when it will reach home base and where it will be when it reaches the plate.

One interesting and important form of anticipation has been called the transit reaction by Hick and Bates (2). Under this rubric these investigators place such activities as "the use of simpler types of bomb-sight, shooting at moving targets by the 'laying ahead' technique, and, in a more complex form, hitting a cricket ball." Diverse as these activities may be, they all have the common feature of involving coincidence-anticipation.

As a means of illustrating the nature of coincidence-anticipation, let it be supposed that a subject (S) is given the simple task of moving his hand off a signal key at the instant a moving marker passes across a fixed marker. In performance of this task there are two possible procedures available to S. First, S may take exact coincidence of the markers to be the stimulus for his response, and second, S may attempt to make his response simultaneous with

coincidence of the markers. If the first procedure is followed, S is not using coincidence-anticipation; under this operating rule the inevitable delays in human sensory-response systems will enter, and S's response will always be one reaction time late. If the second procedure is followed, S may be said to be using coincidence-anticipation, and it is only by anticipating coincidence of the markers that S can possibly avoid being late.

In using coincidence-anticipation, the degrees of success will depend upon S's ability to estimate internal and external conditions. As described by Hick and Bates, when S responds by this method,

> . . . the decision to respond must be taken at least one reaction time *before* coincidence, and, moreover, must be based upon judgments of the velocity of approach, the distance between objects, and the subject's own reaction time, as known to him from previous experience. In other words, it is a case of responding to a combination of misalignment and the rate of change of misalignment . . . (2).

Since people frequently manage to do the right thing at the right time when shooting at moving targets, hitting baseballs and tennis balls, or kicking soccer balls, it seems evident that humans often are extremely successful in compensating for their internal delays and in estimating external constants.

However, except for such generalizations, it appears that few experimental investigations have been concerned with the characteristics and limitations of performance in transit reactions. About the only published material on these reactions has been presented by Hick and Bates (2). These investigators, citing an unpublished study by Bates, state that an experiment on coincidence-anticipation in tank gunnery "showed that reaction time variations could account for practically the whole of the errors." They also note that, "there was no appreciable bias or systematic error, which suggested that the judgments of velocity, etc. may be made with remarkable accuracy."

Hick and Bates have also described a second unpublished study by Bates to illustrate the phenomenon of refractoriness in transit reactions—the designation "refractoriness" being used to indicate "the short period, following receipt of a signal to respond, during which another signal (for a second response) cannot take effect." In this investigation S was given the task of attempting to stop a revolving pointer at the 12 o'clock position by depressing a key. On some trials the experimenter stopped the pointer at various times before it reached the target position, and on these trials S was supposed to inhibit his response. For these test conditions, as explained by Hick and Bates,

> . . . it may be assumed that the arrival of the pointer at the position such that it would be at 12 o'clock about 0.2 seconds later was the stimulus for pressing the key; that is, the subject was to perform a Transit Reaction by the anticipation method, allowing for his own reaction time. The stopping of the pointer by the experimenter was to take effect as a stimulus cancelling the other stimulus (2).

The analysis of S's performance during trials in which the pointer was stopped before reaching the target position revealed four types of behavior:

(1) S was unaware of the pointer stopping and depressed the key; (2) S was aware of the pointer stopping but could not avoid depressing the key; (3) S was aware of the pointer stopping but could not avoid making a slight movement with his trigger finger; and (4) S was aware of the pointer stopping and made no reaction. Using a countdown technique, which assigned zero time to the target position and negative values for time before that position, the mean times for the four behavior types were found to be —70, —150, —210, and —250 msec. respectively. The fact that S could not completely inhibit his response when the signal was presented at times less than 250 msec. before the target position has been interpreted as indicative of refractoriness in transit reactions. As summarized by Hick and Bates, ". . . once a stimulus to action has been, so to speak, accepted by the computing mechanism of the brain, it cannot be cancelled immediately" (2).

Of particular importance for an understanding of transit reactions is the finding that S could not avoid making a full reaction when the second stimulus (stopping of the pointer) was presented as early as 150 msec. before the target position. This indicates a point of no return in the events leading to the reaction. Presumably, these reactions are triggered, and once triggered, they must run their full course. Thus it would appear that transit reactions involve intermittent rather than continuous control.

Another interesting implication in Bates' findings is that the refractory period in transit reactions may be shorter than the normal reaction time. Although Bates did not report reaction-time estimates for his S, the value of 150 msec. for the refractory period would seem somewhat shorter than the normal reaction time to visual stimuli. One explanation for this possible state of affairs, and the intermittent control of transit reactions, is to be found in Craik's (1) speculations relative to delays in the central nervous system. Craik has suggested that reception of a stimulus by the central nervous system involves some computing mechanism which has both latent and processing periods. His evaluation of human responses to successive discrete stimuli has resulted in preliminary estimates of 50 and 450 msec. for these periods. That is, it is postulated that the computing mechanism takes 50 msec. to start operating on a stimulus. Once started, the mechanism requires 450 msec. to process the information and to start discharging impulses down motor nerves.

According to this formulation, if the second of two successive stimuli arrives at the computing mechanism before it has started to operate on the first, both stimuli "may be apprehended together and responded to as a single one" (1). On the other hand, should the second stimulus reach the computing mechanism while it is still processing the first, the mechanism will be insensitive to the second until it has completed its action on the first by discharging impulses down the appropriate motor nerves.

Although Craik's model was developed to account for the nature of human motor performance in continuous tracking situations, his hypothetical computing mechanism possesses the requisite properties for production of transit

reactions. The apparent triggered feature of these reactions may be due to an inability of some computing mechanism to respond to a second stimulus (stopping of a pointer, for example) after it has started to process the stimulus to initiate the reaction. The refractory period of transit reactions may be shorter than the normal reaction time because of a latent period in the computing mechanism. Thus, if a second stimulus, signaling no reaction is to be made, is received during the latent period to the stimulus for the reaction, the reaction may be avoided. On the basis of Craik's model, and his estimate of the computing mechanism's latent period, the refractory period for transit reactions should be approximately 50 msec. shorter than the normal reaction time.

In view of the poverty of data directly concerned with transit reactions and the fact that such reactions are involved in various forms of athletic performance, it was deemed worthwhile to explore the problem further. This report presents the results of two experiments on a simple transit response. The purpose of the first experiment was to obtain estimates of the accuracy and reliability of a transit reaction under conditions of no knowledge of results. The purposes of the second experiment were (1) to obtain estimates of the accuracy of the same reaction with immediate knowledge of results, (2) to obtain estimates of the duration of refractoriness for the transit response, and (3) to compare the duration of refractoriness with a reaction-time measure.

Method

Since the same apparatus and many of the same procedures were employed in both experiments, a general description of the experimental method is here given. Specific details are described in connection with the experiment to which they apply.

Apparatus

In order to provide a measurement situation comparable to the one described by Hick and Bates, the apparatus was constructed so that S would be required to manipulate a signal key when presented with a revolving pointer.

The main apparatus components were a visual display, an electronic chronoscope, a Hunter-Brown interval timer, and a signal key. A model SW-1 Standard Electric Clock, with the second hand removed and the 10-in. dial face replaced with a white cardboard disk, provided the visual display. A ⅛-in. piece of black tape, located at the 800 msec. position on the otherwise blank dial face, provided a fixed target; and the clock's sweep hand, 5¾ in. in length, served as the revolving pointer. This display was hung on a 22 in. × 28 in. vertical panel which was secured to the back of a table. The display was positioned so that the center of the dial face was located 16 in. above the table top. Two 22 in. × 28 in. panels, extending diagonally forward from the back panel, completed the framework from which the visual display hung. The

display was illuminated by means of two lights which were located on either side of the display unit. These lights were shielded from S, and the panels and the display housing were painted flat black to reduce glare.

The chronoscope, a precision laboratory instrument, consisted of a 1000 pulse/sec. generator and a high speed counter. For operation of this instrument it was only necessary to short circuit the control terminals for the duration of the interval to be measured. This caused the generator pulses to be fed into the counter, which recorded pulse counts on cold cathode glow-transfer tubes. Effectively, this counting system indicated elapsed time in msec.

The Hunter-Brown interval timer functioned as a switch for simultaneously starting the display pointer and chronoscope. This unit also determined how long the pointer would revolve. A signal key served as a pick-up device for S's response. Depending upon the measurement situation involved, operation of the key would either stop the chronoscope or it would stop both the chronoscope and the pointer. Operation of this key also lit a NE-51 neon lamp, which provided the experimenter with information regarding S's behavior during trials designed to measure refractoriness.

Procedures

In both experiments, S sat at the table upon which the visual display was attached, the viewing distance being approximately 60 in. The signal key, located at S's end of the table, was not secured to the table top so that it could be placed in any position S believed to be most comfortable. In operating the key, S rested his forearms on the table, held the key in position with his left hand, and depressed the key's button with the fingers of his right hand; in releasing the key, S moved his right hand directly upward.

Standardized instructions and demonstrations were presented at the start of each measurement session. Each trial was started with the pointer resting at the 12 o'clock position. At the start of a trial, the experimenter gave the command "Ready," which was the signal for S to depress the key. Approximately three seconds later, the pointer and chronoscope were started. S was given 10 practice or warm-up trials at the beginning of each session. Regular trials were administered in blocks of 25 trials, with a two-minute rest period between blocks. Although the number of sessions varied between the two experiments, all sessions were completed at the same hour on successive days. For all measurement sessions, the two lamps which were located on either side of the display provided the sole source of illumination.

Scoring and Analysis of Performance

A time measure was used for scoring performance in transit reactions, the measure being the time between the start of the revolving pointer and movement of S's hand off the key. Evaluation of performance for these reactions was in terms of absolute and constant errors. The absolute error provides a gross measure of performance, which is based upon the difference (sign ignored) between S's score and the time required for the revolving pointer

to reach the target marker (800 msec.). Thus, while providing a measure of error magnitude, it does not indicate whether S, on the average, tended to react before or after the revolving pointer reached the target marker. The constant error, on the other hand, provides a measure of the direction of transit error. It is equal to S's mean transit time minus the standard time of 800 msec. When S's mean transit time is longer than the standard, the constant error will be positive; when the mean time falls short of the standard, the constant error will be negative.

Pearson product-moment coefficients, computed for measures obtained on successive days, provided estimates of the reliability of transit and reaction-time responses. The significance of differences between means for successive days and different experimental conditions was evaluated by means of F and t tests.

Experiment I

Procedures. Nineteen male and six female Ss were recruited from the faculty, student body, and clerical staff of the School of Health, Physical Education, and Recreation, Indiana University. Their ages ranged from 19 to 62 years, their median age being 29 years. Although all Ss had participated in previous laboratory experiments, they were naive to the apparatus and task of the present experiment on transit reactions.

Ss were given the task of releasing the signal key when the revolving pointer coincided with the target marker; as emphasized in the instructions and demonstrations, movement off the key was to be simultaneous with coincidence of the pointer and target. On these trials, the pointer ran for 1250 msec. (1¼ revolutions); the chronoscope, until S released the key. Ss completed 100 trials daily for two consecutive days. At no time during the measurement periods were Ss informed of their scores.

Results. Table 1 presents the mean errors in transit reactions when Ss received no information on their performance. As can be seen, the absolute errors for two test days were practically identical, the difference between means being only 1 msec. With a difference of this magnitude, it was superfluous to test the significance of the difference between absolute error means, and the two sets of measures were pooled to obtain a single measure of performance. For the 25 Ss in this experiment, the absolute error for transit reactions was found to be approximately 28 msec.

The correlation between absolute error scores for two days was found to be .95. This coefficient is sufficiently high to encourage confidence in the consistency of error measures in transit reactions.

TABLE 1.—ERRORS (IN MSEC.) FOR TRANSIT REACTIONS WITHOUT KNOWLEDGE OF RESULTS

Test Days	Absolute Error		Constant Error
	Mean	S.D.	
Day 1	27	19	—3
Day 2	28	18	4
Days Combined	28	19	1

A comparison of constant errors for two test days (Table 1) revealed no uniform bias; that is, these errors were not consistently plus or minus. Furthermore, since the mean constant error was never greater than four msec., it would seem evident that Ss, as a group, exhibited no marked tendency to be early or late in making transit reactions. These results are consistent with Bates' finding of "no appreciable bias or systematic error" when Ss completed transit reactions without knowledge of results.

Experiment II

Procedures. Ten male students who had participated in the first experiment were utilized as Ss. Their ages ranged from 19 to 33 years, their median age being 25 years. Each S completed nine test periods under the following schedule and conditions:

(a) On days 1 and 2, Ss completed transit reactions under conditions which provided immediate knowledge of results. For these trials the apparatus was operated so that movement of S's hand off the key simultaneously stopped the chronoscope and the revolving pointer. This operating condition not only provided Ss with knowledge of the direction and magnitude of errors but it made the task one of attempting to stop the pointer on the target. Ss completed 100 daily transit reactions.

(b) On days 3, 4, 5, 6, and 7, Ss again completed transit reactions under conditions which provided immediate knowledge of results. These trials, however, differed from those of the first two days in that catch trials were introduced; that is, the pointer was occasionally stopped at specific intervals short of the target. Ss, of course, were to watch for this and keep the key depressed whenever such an event occurred. During catch trials the pointer was stopped from 70 to 230 msec., in steps of 10 msec., before it reached the target. Ss completed a total of 125 trials a day, and each day's schedule included a randomized presentation of 91 regular and two repetitions of the 17 different intervals for catch trials. S's performance for catch trials was monitored by means of a neon lamp circuit. The operation of this circuit was such that movement of S's hand off the key caused the lamp to glow.

(c) On days 8 and 9, Ss completed reaction-time responses to stopping of the revolving pointer. During these trials the pointer was stopped at the 500, 600, 700, or 800 msec. positions. These intervals were presented in a random order with the restriction that each interval be presented 25 times in a daily series of 100 trials.

Results. Table 2 summarizes the mean error for transit reactions when Ss received immediate knowledge of results. The absolute errors for two successive days was found to be six and nine msec. This difference of three msec. was not significant ($t<1$; $P>.05$), and the results were pooled to obtain a single error estimate of approximately eight msec. From this detached experiment, the magnitude of error suggests that transit reactions with knowledge of results can be remarkably accurate.

TABLE 2.—ERRORS (IN MSEC.) FOR TRANSIT REACTIONS WITH IMMEDIATE KNOWLEDGE OF RESULTS

Test Days	Absolute Error		Constant Error
	Mean	S.D.	
Day 1	6	6	2
Day 2	9	7	—4
Days Combined	8	6	—2

TABLE 3.—ERRORS (IN MSEC.) FOR TRANSIT REACTIONS WITH IMMEDIATE KNOWLEDGE OF RESULTS AND CATCH TRIALS

Test Days	Absolute Error		Constant Error
	Mean	S.D.	
Day 3	28	16	28
Day 4	25	11	25
Day 5	27	12	27
Day 6	25	13	25
Day 7	25	10	25
Days Combined	26	12	26

The correlation between absolute error scores for two test days was found to be .84. Although this coefficient falls somewhat short of that obtained for 25 Ss in the earlier experiment, it is high enough to suggest passable reliability for measures of transit reactions.

Since all Ss in the present experiment have also performed in the earlier experiment, it was possible to compare the difference in error when transit reactions were performed with and without knowledge of results. The absolute error without knowledge of results was 26 msec., which was significantly greater ($t=4.01$; $P<.01$) than the error of eight msec. for performance with knowledge of results. This, of course, merely confirms the well-supported principle that performance with knowledge of results is invariably better than performance without such knowledge. However, it is of some interest to note that, for the Ss in this experiment, the error for performance without knowledge of results was, roughly, 300 percent greater than the error for performance with knowledge of results.

Inspection of constant errors for transit reactions with knowledge of results (Table 2) indicated that these errors were comparable to those obtained for performance without knowledge of results (Table 1); there was no systematic bias and the maximum error under both experimental conditions was four msec. This agreement would seem inevitable; since the findings for performance without knowledge of results led to the conclusion of "no appreciable bias or systematic error," it would be difficult to imagine how performance of the same task with knowledge of results could lead to the accumulation of constant errors.

Table 3 summarizes the errors for transit reactions with immediate knowledge of results and catch trials. Inspection of absolute errors for consecutive

test days revealed little in the way of systematic change in performance, and the analysis of variance for repeated measures (Table 4) indicated no significant differences ($P > .05$) between successive test days. On the basis of this finding, the results for successive days were pooled to obtain a single estimate of absolute error. For the 10 Ss in this experiment, the absolute error was found to be 26 msec.

TABLE 4.—ANALYSIS OF VARIANCE FOR ABSOLUTE ERRORS IN TRANSIT REACTIONS DURING FIVE SUCCESSIVE TEST DAYS

Source	d f	Mean Square	F	P 5%
Subjects	9	675.058	29.78	2.15
Days	4	24.780	1.09	2.63
Error	36	22.669		

The introduction of catch trials during performance of transit reactions with immediate knowledge of results appeared to have a pronounced effect upon the magnitude of absolute error. Without catch trials the pooled error was eight msec.: with catch trials, 26 msec. This difference was statistically reliable ($t = 4.43$; $P < .05$). Further insight into the effect of catch trials upon transit reactions can be gained from inspection of constant errors. As shown in Table 3, the constant errors for successive test days were always positive and of the same magnitude as the absolute errors. Evidently the anticipation of a possible catch trial caused Ss to delay their reactions beyond the time required for successful performance.

Although the nature of the relationship is not clear, it is of some interest to note that the pooled absolute error of 26 msec. for transit reactions with knowledge of results and catch trials was identical with the pooled error produced by the same Ss for performance without knowledge of results.

A graphic summary of the data for assessing the refractory period in transit reactions is presented in Figure I. This summary, based upon the pooled reactions for all Ss, shows the percent of times Ss could not avoid making a reaction when catch trials were presented from 70 to 230 msec. before the target position. It can be seen that the behavior ranged from always reacting when catch trials occurred from 70 to 75 msec. before the target position to seldom reacting when catch trials occurred 170 msec. or more before the target position. Between these extremes there was a systematic decrease in reaction as the time for stopping the pointer, relative to the target, was increased. Evaluation of data in terms of a threshold value—the threshold being defined as the catch trial interval in which Ss reacted 50 percent of the time—resulted in a refractory period estimate of 140 msec. Presumably, this represents the point in time, before coincidence of the pointer and target, when Ss triggered their transit reactions. And it appears that a stimulus presented after this point in time cannot be acted upon.

However, when errors for transit reactions with knowledge of results and catch trials are considered, it would seem evident that the estimate of 140

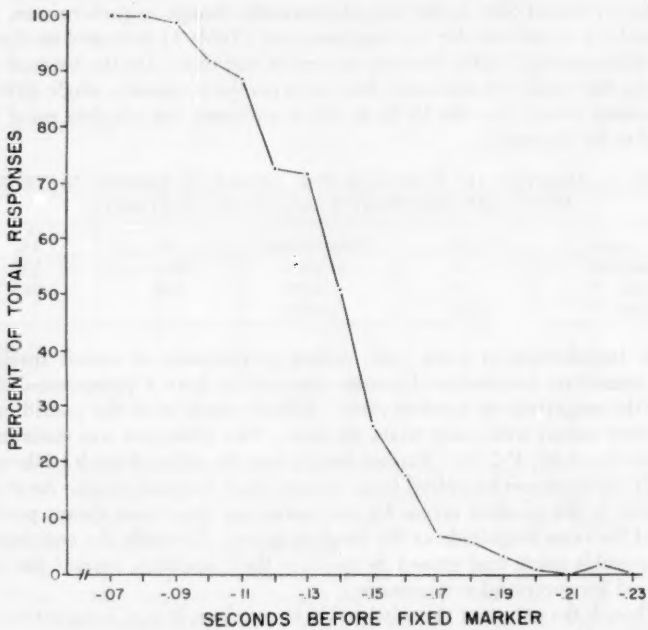

FIGURE I. Percentage of responses as a function of time before target position.

msec. for the refractory period falls somewhat short of the probable value. As previously noted, the introduction of catch trials, which was a necessary condition for obtaining estimates of the refractory period, resulted in a constant error of 26 msec. This indicates that Ss delayed initiating their transit reactions beyond the time required for successful performance, and this delay would shorten the apparent refractory period by an amount equal to the constant error. Correcting for this delay would place the "normal" refractory period 26 msec. earlier in time; that is, it would change the estimate from 140 to 166 msec. It is suggested that the corrected estimate of 166 msec. is more representative of the probable refractory period for Ss in this experiment.

Table 5 presents the means and standard deviations for reaction-time measures to stopping of the revolving pointer. Although the direction of the difference between means suggests a slight improvement in performance over two successive test days, this difference was not significant ($t<1$; $P>.05$). Combining means for days resulted in a reaction-time estimate of 221 msec. The correlation between reaction-time measures for successive days was found

TABLE 5.—REACTION-TIME MEASURES (IN MSEC.) TO STOPPING OF REVOLVING POINTER

Test Days	Mean	S. D.
Day 8	222	17
Day 9	220	18
Days Combined	221	18

to be .88, which is comparable to the coefficients obtained in various reaction-time situations.

While there is no assurance that reaction time to stopping of a revolving pointer is the same as that for perception of the arrival of a pointer at a particular point in space, which appears to be the kind of stimulus responded to in transit reactions, the data of this experiment provide a rough check on one prediction arising from Craik's model of a central computing system. This prediction, as noted earlier, is that the refractory period for transit reactions will be approximately 50 msec. shorter than the reaction itme.

Since the pooled reaction time and the measured threshold refractory period were 221 and 140 msec. respectively, the direction of the difference is as predicted. However, the refractory period is considerably shorter than the expected value of 171 msec. This discrepancy may be largely explained by the fact that Ss were consistently late in making their transit reactions. When allowance is made for constant errors, the resultant refractory period estimate of 166 msec. comes within five msec. of the predicted value. In general, then, the results of this experiment would appear to be in rough agreement with the prediction arising from Craik's model of a central computing mechanism.

Summary

Two experiments were conducted to obtain estimates of the reliability, accuracy, and refractoriness of transit reactions. In both experiments, Ss attempted to make a simple hand response to coincidence of a revolving pointer and fixed marker. Performance was evaluated by means of absolute and constant errors.

In Experiment I, 25 Ss performed without knowledge of results or catch trials. In Experiment II, 10 Ss from Experiment I performed under the following conditions: (1) with immediate knowledge of results but no catch trials, and (2) with immediate knowledge of results and catch trials. Ss in the latter experiment also completed reaction-time responses to stopping of the pointer. The essential results for transit reactions were:

a. The test-retest reliability coefficients were sufficiently high to encourage confidence in the consistency of measurement.

b. For experimental conditions without catch trials, knowledge of results had no marked effect upon constant errors. Performance with and without knowledge of results was remarkably free of systematic bias.

c. For experimental conditions without catch trials, knowledge of results had a pronounced effect upon the accumulation of absolute errors. The error for performance with knowledge of results was significantly smaller than for performance without knowledge.

d. The introduction of catch trials had a pronounced effect upon absolute errors. The error for performance with knowledge of results and no catch trials was significantly smaller than that for performance with knowledge of results and catch trials.

e. The introduction of catch trials had a pronounced effect upon constant errors. Whereas performance with and without knowledge of results, but no catch trials, showed no systematic biases, performance with knowledge of results and catch trials resulted in large and positive constant errors.

f. The measured threshold refractory period was found to be 140 msec. Allowing for positive systematic bias in transit reactions increased the estimated threshold to 166 msec.

The extent to which the results of this experiment agree with previous findings was noted.

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(Submitted 8/9/59)

Notes and Comments

NOTES

Relationship Between Audio-Perceptual Rhythm and Skill in Square Dance[1]

PATRICIA ANN BLAKE
Northern Illinois University
De Kalb, Illinois

The purpose of this study was to investigate the relationship between scores on the Seashore Test of Audio-Perceptual Rhythm and subjective estimates of skill in square dance. Lemon and Sherbon (3), Benton (2), and Annett (1) have reported low but significant correlations between scores on the Seashore Test and various estimates of skill in dance or rhythmic movement. No studies of relationships between measures of audio-perceptual rhythm and square dance have been reported. The patterns in rhythm for square dancing are rather limited in scope in comparison with other forms of dance. It seems, therefore, that the motor and sensory rhythm requirements for square dance might differ from those of other areas of dance.

This study was made to provide answers to the following questions:

1. What is the significance of mean differences in audio-perceptual rhythm on the basis of square dance skill?
2. What is the degree of relationship between initial and final audio-perceptual rhythm scores?
3. Is there progress made in audio-perceptual rhythm as measured by the Seashore Test as a result of classroom square dance instruction?

Procedures Followed

The subjects for this study included 70 men and women students from three beginning square dance classes of the Departments of Required Physical Education for men and women at the University of Florida. The classes met twice a week for one-hour periods over a 15-week semester.

A jury of three raters determined the initial and final levels of skill of each student. One judge was a physical education instructor in the women's department with previous experience in the teaching of all phases of dance. The second was an instructor in the professional curriculum with previous experience in organizing, calling, and teaching square dance both in the schools and community. The third was an instructor actively engaged in the organizing and teaching of square dance in Florida communities.

A rating scale was developed for use in determining skill in square dance. The scale was divided into three phases of square dance: (a) rhythm; (b) style; and (c) response to the caller. Rhythm was defined as the relative degree of conformance of bodily movements to the musical pattern. Style was judged in terms of the degree of skill employed, and in terms of the continuity of movements in the entire dance. Each student was ranked from one to five on the basis of excellence in each of these three components. The total of these rankings constituted the skill grade.

The raters were asked to judge the students on the basis of their own experience in square dance. Since each member of the rating jury was an expert in his own right, the

[1] This study was done under the supervision of W. H. Solley, University of Florida.

ratings indicated skill levels based on a wide range of experience in square dance. Hence the skill scores reflect philosophies gained in diverse square dance experiences, and therefore more nearly reflect the total square dance field rather than specific school situation.

Each class was divided into sets for the skill test. Students wore lettered tags while dancing. The students were rated one set at a time, with the remainder of the class staying away from the testing area until their turn came.

To provide a means for evaluating initial skill a tape recording was made. The calls on this tape were based on the skills taught during the first four weeks of instruction. The judges, using the rating scale, evaluated each student on the basis of the three items on the scale.

The Seashore Test was administered in the first class period following these ratings. This test determines the extent to which the individual recognizes various rhythmical patterns through the audio-perceptual mechanism. The rhythmical patterns, presented by means of a recording, vary in difficulty from very simple to very difficult.

After eleven weeks of additional instruction, a new skill test was made on the basis of all the skills covered by the individual instructor.[2] The second skill test was administered through a microphone by a leading caller in the state of Florida and in the Southeast.

At the next class meeting following the administration of the final skill test, the Seashore Test was administered again to each of the three classes to obtain a final score for each class member in audio-perceptual rhythm.

Analysis of Data

To determine the role of audio-perceptual rhythm in square dance skill, the students in the three classes studied were placed into three approximately equal groups on the basis of the skill ratings of the jury of experts. Thus, three groups of square dancers were determined; one of above-average ability, one of average ability, and one of below-average ability.

The t-test was then used to test the hypothesis that the true differences between mean audio-perceptual scores of these groups were actually zero, i.e., that no statistically significant difference existed between the mean audio-perceptual rhythm scores of the three groups with differing square dance abilities.

Table 1 indicates the results of the statistical computations based on initial scores.

TABLE 1.—T-TESTS OF MEAN AUDIO-PERCEPTUAL RHYTHM SCORES OF SKILL GROUPS AT BEGINNING OF STUDY

Groups	N	M	Pooled σ m	t	df	P
Average	24	25.4	.78	.384	47	.80
Below Average	25	25.1				
Above Average	21	26.7	.72	1.810	43	.10
Average	24	25.4				
Above Average	21	26.7	.71	2.250	44	.05
Below Average	25	25.1				

The observed difference between the below-average and above-average groups was found to be significant. The hypothesis that the true difference was zero was rejected at the 5 percent level of confidence.

[2] The author was handicapped by the fact that a single instructor did not teach all three classes. Although the vast majority of materials in the three classes was emphasized approximately equally, one class did master fewer dances than the other two.

Table 2 indicates the results of the statistical computations based on final scores. The average, below average, and above average skill groups represent the level of skill as determined at the conclusion of the study. Many students shifted from one group to another as a result of the 15 weeks of instruction. The reader should be aware of the fact that the skill groupings do not represent the same students at the beginning and at the end of the study.

TABLE 2.—T-TESTS OF MEAN AUDIO-PERCEPTUAL RHYTHM SCORES OF SKILL GROUPS AT END OF STUDY

Groups	N	M	Pooled σ m	t	df	P
Average	24	26.7	.71	2.39	48	.05
Below Average	26	25				
Above Average	20	27.2	.36	1.38	42	.20
Average	24	26.7				
Above Average	20	27.2	.91	2.85	44	.01
Below Average	26	25				

After 15 weeks of square dance instruction, statistically significant differences of the mean audio-perceptual scores were found between the average and below average groups and the above average and below average groups. No such significance could be placed on mean scores of the above average and average groups.

A slight but significant relationship was found between the skill scores at the beginning and skill scores at the end of the study. The coefficient of correlation was found to be .39, which was significant at beyond the 1 percent level of confidence. The relationship between initial and final audio-perceptual scores was also small but significant. In this instance the coefficient was .47.

Summary of Findings

The study resulted in the following findings:

1. Audio-perceptual rhythm showed some relationship to skill in square dance with the relationship appearing to be slightly more significant after a period of square dance instruction.
2. Only a slight tendency was shown for students to maintain the same relative position in the group during a reasonably long period of instruction in square dance drill.
3. A small but significant relationship was observed between initial and final audio-perceptual rhythm scores.

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(Submitted 8/12/59)

Laboratory Research in Physical Education

RICHARD J. DONNELLY
University of Minnesota

A SEARCH OF the literature reveals that Hunsicker (1) made a survey of laboratory facilities in physical education in 1950. This writer was in the process of establishing a research laboratory in physical education at the University of Minnesota and needed more current data to serve as a guide in the project. Consequently, a questionnaire was sent to the directors of physical education for men in 124 colleges and universities throughout the United States. Completed questionnaires were received from 83 schools (67%). The data were current for the spring semester (term) 1958.

Schools with Research Laboratories

A total of 28 schools reported that they had a physical education research laboratory. The largest percentage of the research laboratories in physical education have been established since 1950—a total of 22 out of the 28. There is reason to believe that this number has already increased, because five schools without a laboratory indicated that they were planning to develop one in 1958-59.

Size of Laboratory

The schools offering a doctor's degree had more rooms and more sq. ft. of floor area in their laboratories than those schools offering only bachelor's and/or master's degrees. In number of rooms the former ranged from 1 to 7 with a median of 4 while the latter had a range from .5 to 4 with a median of 2. In sq. ft. of floor space the research laboratories in the schools with a doctoral program ranged from a low 405 to a high of 3800 with a median of 2000 sq. ft. The laboratories in the schools without a doctoral program were as small as 100 sq. ft. but as large as 6500 sq. ft. with the median being 1366 sq. ft. These figures indicate that in 1958 the research laboratories in physical education were two to three times larger in size than the median 650 sq. ft. reported in Hunsicker's 1950 survey.

Administration and Use of the Laboratory

To the question "How is your laboratory administered?" approximately one-half answered the men's physical education department; the other one-half indicated administration by a coeducational department of men and women or jointly by the men's and women's departments of physical education. The laboratory is more likely to be conducted jointly if the school has a doctoral program. In one institution the laboratory is administered by the physiology department.

Many of the laboratories operated by the men's physical education department offer free access to the women faculty and students. A study of the figures on the use of the laboratory by faculty and students would lead one to conclude that greater utilization of the laboratory, especially by the women, is obtained through joint administration of it.

The over-all use of the research laboratory varies from very limited to very heavy. The greatest usage, as one might expect, is in those schools with an extensive doctoral program. For example, the median number of men graduate students using the laboratory was 12 in the doctoral program schools and 2 in the others, men faculty 3 in the doctoral schools and 1.5 in the others. So few women carried on research in the laboratories of nondoctoral schools that comparisons cannot be made. However, the median number of women faculty doing research in the laboratories of the schools with a doctoral program was 1, and of the women graduate students 3. It is interesting to note that in a few schools, faculty from other university departments, such as music, agriculture, physiology, and zoology, did work in the physical education research laboratory.

In six institutions physical education faculty are assigned to full-time responsibility in the research laboratory; five of these schools conduct a comprehensive doctoral

program. A few of the other schools assign one faculty person part-time responsibility to direct the research laboratory but he carries other duties also. Other full-time personnel found in a physical education research laboratory include a secretary in two schools and a technician and a statistician in only one school. Three schools employ a lab technician on a part-time basis while five use a part-time secretary. One school also utilizes a physician part-time. All but 7 of the 28 schools have the services of one or more graduate assistants in the laboratory with the range being from 1 to 10 and the median 2.

Budget

The question was asked "Do you have money for research in your budget?" and 20 of 83 respondents said yes. Only three schools without a research laboratory answered in the affirmative. Some of the schools answering no qualified their response by stating that there was no planned allotment for research but some money, usually a limited amount, could be spent for research. The money allocated for research in 1957-58 ranged from a low of $200 to a high of $6560 and median of $2000. This does not give the entire picture because some schools receive research grants from other sources. As an example one school stated that outside grants raised the total research budget to $80,000.

Seventeen of the schools with a research laboratory and five without one obtained money for research from a source other than their regular budget. First in frequency among these other sources were the university funds found in such places as the research council, research fund, graduate school, and special funds of the university. Research money was also received from state and national groups such as the Federal Trade Commission, National Heart Institute, United States Air Force, United States Office of Health, Education, and Welfare, State Department of Education, and State Health Association. Well-known foundations, such as the Ford Foundation and the Kellogg Foundation, gave money indirectly by including physical education and health education as phases of broader projects. In addition, grants were obtained from private concerns such as insurance companies and manufacturers.

In most schools the greatest research expenditure was for equipment. Money was also spent in varying amounts for the following items: facilities, secretarial help, technicians, statistical analysis, travel, subjects for testing purposes, and research assistants.

The respondents were asked to estimate the amount of money that it would cost to replace the equipment currently in their research laboratory. The range was from $500 to $75,000 with a median of $10,000.

Major Areas of Emphasis

The schools with research laboratories were asked to list the five major areas of emphasis in the studies conducted in their laboratories. Since some of the schools were just getting under way in their laboratories, they had nothing to report. For those who did report, however, the studies seemed to fall into three broad categories—physiological, psychological, and kinesiological.

The physiological emphasis was far in the ascendancy, and physical fitness studies or various aspects of physical fitness dominated the laboratory research being done in physical education. Examples of physiological areas of emphasis are as follows: strength, power, muscle testing, physiology of strength and related problems, oxygen in exercise, oxygen debt, fatigue and recovery time, recuperation and fatigue, fatigue and endurance, effects of exercise programs, cardiovascular energy cost studies, relation of strength to aging, reaction time, hypertension of muscles, electroencephalographic studies, ballistocardiograph technique, gastro-coronary reflexes, innate capacities, growth and development, longevity and exercise, and conditioning.

There were also studies with psychological emphasis including motor learning, emotional responses, motivation, behavior, biological nature of the learning process, and sports psychology. Sports mechanics was the main emphasis in kinesiological research.

Interpretation of Findings

This survey indicates that laboratory research in physical education education has made rapid strides in the past few years. Research laboratories are being established at an accelerated pace. They are larger and more expensively equipped than their prototypes (2). They are being staffed with highly competent and specially trained personnel. The opportunity for graduate students and graduate faculty to do basic and applied research in physical education is greater than ever before, and it appears that this opportunity will continue to increase.

References

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Appendix

The following colleges and universities offering bachelor's and/or master's degrees have physical education research laboratories. The date of their establishment follows in parenthesis. An asterisk (*) indicates schools offering doctorates.

*Springfield College (1920)
George Williams College (1923)
*University of California (Berkeley) (1936)
*University of Illinois (1941)
*Indiana University (1948)
*New York University (1948)
*University of Southern California (1950)
*University of Texas (1950)
*Boston University (1951)
University of Florida (1951)
University of Wisconsin (1951)
University of Kansas (1953)
*University of Maryland (1953)
*University of Michigan (1953)
*University of Oregon (1953)
*State University of Iowa (1954)
*Michigan State University (1954)
Texas A & M (1954)
University of Connecticut (1955)
Utah State University (1955)
*State College of Washington (1955)
Brigham Young University (1956)
University of Kentucky (1956)
Florida State University (1957)
Southern Illinois University (1957)
*University of Arkansas (1957)
*University of California at Los Angeles (1957)
*Louisiana State University (1957)

(Submitted 5/6/59)

A Plea for Better Scholarship in Research Reports

FRANKLIN M. HENRY
University of California
Berkeley, California

PUBLICATION OF a research report is a serious scientific responsibility. The data must be evaluated critically with respect to agreement and disagreement with both new and antecedent hypotheses and theories. Scientific ethics require that prior research be ferreted out and brought to bear on the problem, seeking as avidly for disagreement as for agreement. The research worker must be encouraged to present new theories, even though they clash with tradition and are thus subject to attack and may cause unpopularity. It must be demanded of him, on the other hand, that he explore the weaknesses of his own theoretical positions even though they may be popular and generally

accepted at the moment. Only by following these precepts can we hope to arrive at scientific truths.

The research articles that we publish in our RESEARCH QUARTERLY, even though read by three associate editors, are sometimes rather inadequate. Consider a recent report that makes use of the relationship between reaction time and speed in sprint running to substantiate a theoretical position (3). The nonspecialist reader of this report is left with the impression that it has been established that there is a high correlation between these variables; references are cited to establish the point, but this misleads the reader. Several studies (not cited) have in fact found that the correlation is either zero or very small (1). Moreover, (contrary to the evidence cited), another experiment reported some years earlier showed only a small and nonsignificant correlation between reflex muscle contraction time and sprint speed (5). The writer of the recent report has given no recognition to the work of these other researchers. He has (probably unintentionally) cited only those references that are favorable to his hypothesis. Furthermore, there is no mention of published research to the effect that Negro children do not have faster reaction time than whites (2), and no consideration of an alternative hypothesis that would ascribe the observed results to possible age differences between the racial groups at a given grade placement. It would seem that the associate editors, who, by evaluating the manuscript, have implicitly claimed to be competent in and familiar with factual data in the area of the study[1], should have been more helpful in cases such as this one.

The particular article that receives critical comment in the above paragraph obviously came to the present writer's attention because it concerned an area in which he has had a personal research interest. It is not difficult to find other examples in the RESEARCH QUARTERLY that illustrate inadequate or selective citations of prior work, with the accompanying hazard of biasing the interpretation of the state of our knowledge in a particular area.

This is not to hold that every article need be preceded by an exhaustive review of the prior research. Sometimes an author can take advantage of an existing review, mentioning that he has brought it up to date with the additional references that he cites. This has been done for example in another recent article on a different topic (4). Unfortunately, the reviews of the literature in many of our articles are not as dependable as they should be. All too often they are incomplete with respect to the citation and consideration of prior studies of specific relevance, even though the reference lists are sometimes lengthy and typically include articles that have only a vague relationship to the problem.

Improvement in the situation will require a cooperative effort. It would be difficult to refer an author (or prospective author) to a definite source that would give him simple and adequate directions that, if followed, would automatically result in a competent review of prior or related research. He would be well advised to study, both comparatively and critically, the published writings of others; if he does so he will discover that good scholarship is self-evident. He will also discover that quite a few of our research reports show poor scholarship in other ways than inadequate consideration of the work of other investigators, although such cases are less common in the last few years. A recent note has discussed one area of weakness (6).

Associate editors could well play a more effective role in the needed cooperative effort for improvement. Certain ones among them should exhibit more sympathetic and noncondescending aid with important aspects of a possibly inadequate report, and less concern with esoteric trivia. One associate editor requires that there be no zero before the decimal point when reporting a correlation coefficient; another, convinced perhaps that every article must be given some critical comment, states that "decimal correlations"

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[1] See "General Statement of Function of Associate Editors," October 1951 issue of the *Research Quarterly*, p. 392-93, and the reaffirmation on p. 354 of the May 1959 issue.

should be preceded by a zero.[2] Is it not extremely authoritarian to rule that acceptance for publication of an excellent article hinges on required revision of such things as use of the term "level of significance" rather than "level of confidence," or the "explanation" of a commonly used statistical symbol such as r_{12}? Many of our younger authors are quiet competent in both their research and their writing. They are becoming resentful of such actions.

Elevation to a position of authority with the accompanying protection of anonymity should create a feeling of humility in the person who receives this mark of confidence; he should be willing to learn how to exercise his power in a manner oriented to foster rather than veto the publication of the research of his colleagues. Most, but unfortunately not all, of our associate editors accept their appointment in this spirit. Mutual respect and confidence is required in order to achieve the cooperative attitude that is essential if we are to improve the scholarship of our research reports.

It is also important that authors be receptive to experienced advice, and be willing to accept suggestions or requirements designed to improve their articles. Moreover, with the proper attitude, even a poorly worded or unjust evaluative statement can often be turned to the improvement of an author's manuscript, provided that he will re-read it after his first (and normal) wave of indignation has passed.

References

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3. Huttinger, P. W. "Differences in Speed Between American Negro and White Children in Performance of the 35-Yard Dash." *Research Quarterly* 30: 366-67; October 1959.
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(Submitted 12/29/59)

Research on Muscle Development

A. T. SLATER-HAMMEL
Indiana University

UP TO THE LAST decade or so, the empirical principle that "use promotes growth" was accepted as a sufficient guide for the organization of programs designed to help our weak and undermuscled students. In applying this principle it was only necessary to provide students with a program of exercises and activities which required vigorous use of the skeletal muscles and resulted in a healthy sweat. While there were always different schools of thought on the value of particular exercises and activities, the general utility of almost all such programs was readily evident to anyone willing to observe student progress.

Lately, however, there has been a trend to refine our understanding of the "use" principle. Our researchers in physical education have become concerned with "quantitative information" on muscle development for normal and pathological groups; they are ex-

[2] These examples, and other similar ones, can readily be documented.

ploring the relationships between muscle development and such variables as type of muscle contraction (isometric vs. isotonic), muscle loading, number of successive contractions in an exercise bout, and time interval between exercise bouts. This work has exciting possibilities. Its importance cannot be overestimated because it offers the promise of improving our understanding and of providing us with basic information for development of the most efficient exercise and activity programs.

But exciting and promising as the possibilities may appear, it is now beginning to look as though the road to understanding and basic information will be long and tortuous. The reason for this depressing prognosis? A disproportionate number of researchers working in the area of muscle development have not come to grips with the diverse problems of experimentation. In some instances researchers have ignored formal details—including in this designation such crucial issues as replication, randomization, and control—and no reasonable conclusions are possible from their experiments, although this is seldom a deterrent to publication. In other instances researchers have been successful in formal matters, but their selection of treatment comparisons is such that it becomes impossible to arrive at acceptable information on the probable cause for observed treatment differences.

When a researcher investigating the differential effects of static vs. concentric muscle contractions states,

"The fact that the results of this study may not be attributed solely to the weight training program does not negate its value. It remains for other investigators to determine what part of the total contribution is made by the numerous factors which influence the development of strength . . . the author is convinced that strength gains will be achieved by using either static-contractions or concentric-contractions."

it becomes obvious that formal inadequacies preclude any reasonable conclusions on the effects of exercise treatments upon strength development. Unfortunately, the causes for these abortive research efforts are varied, and suggestions for correction cannot be readily made within the confines of a brief note. For this class of research reports it only can be hoped the researchers will become alert to the challenge and fascination of experimentation.

In regard to the second group of experiments—those which are formally adequate, but which do not provide information on the reason for treatment effects, and thus contribute nothing to the understanding of processes involved—the source of trouble and its correction is more readily described. Consider, for example, a recent Research Quarterly report on the effect of two exercise treatments upon the development of isometric strength. Under one treatment condition, "two-thirds tension was held by each subject for only six seconds each day, Mondays through Thursdays." Subjects in the other condition "held 80 percent of the maximum tension for five periods of six seconds each on Mondays, increasing the number of exercise bouts once each day with a maximum of eight on Thursdays." A third group of subjects was used as controls, all groups of subjects were equated on initial strength tests, the testing and exercise conditions were carefully controlled, and other conditions were fulfilled. All in all, the researchers devoted a lot of time and energy in setting up an experiment which was formally adequate for assessing the significance of the difference between exercise treatments.

However, in spite of this formal adequacy, there is on basic fault in the researchers' experimental design. The fact that the two exercise treatments differed in both the amount of tension and the frequency of exercise bouts makes it impossible to arrive at a unique interpretation of treatment effects. This difficulty and the logical trap it entails is illustrated in the following conclusion:

". . . it would appear that greater tension exerted more frequently is somewhat more effective in maintaining strength once it is developed than is the single daily six-second bout at two-thirds maximum."

This, of course, is one possible way of accounting for treatment differences. But the mere fact that the researchers elected to have their two treatment groups perform at

different levels on two experimental variables does not guarantee that any effects will be due to the influence of both variables. There are, in fact, three possible explanations for the obtained effect. It might have been due to greater tension, to more frequent exercise bouts, or to the combination of greater tension and more frequent exercise bouts. Unfortunately, the researchers' confounding of treatment comparisons makes it impossible to discriminate between logical alternatives when attempting to account for observed treatment differences.

This is not to say that no conclusions are possible with confounded experimental variables, for it can always be concluded that one set of treatment conditions is or is not more effective than another set. But an empirical conclusion of this type, though it may have utilitarian value in some particular applied situation, and though it may represent a shotgun approach to the problem of locating possible variables, seldom can be said to qualify as a scientific contribution. First, it is uncertain because it cannot answer the question as to whether or not all variables in a treatment condition are essential. Thus, it does not supply information on the probable cause of a treatment difference, which is essential if basic knowledge is to be obtained. Second, it is trivial in the sense that it represents only one of the almost endless numbers of conclusions which would flow from haphazard combinations of different experimental variables and different magnitudes of these variables.

In the hope of hastening the day when basic knowledge on muscle development will become available, it is suggested that our researchers in this area give attention to the nature of their treatment comparisons. The ambiguities described above may be avoided by following one useful rule: *vary the treatment comparisons in a single, clearly specified way.* This rule is not intended to convey the impression that all confounding is necessarily bad, for there are research conditions in which deliberate confounding is perfectly sensible and serves a useful purpose. Such practices, however, require a fairly high level of research sophistication and should be avoided by the casual researcher. Furthermore, the rule does not imply a return to the earlier practice of "varying the factors one at a time" in an experiment; it does mean our researchers on muscle development will need to use more treatment comparisons in their experiments than has been the common practice.

Finally, it is suggested that the current practice of comparing haphazard combinations of experimental variables is little more than a tiresome distraction. It is a flimflam game which may serve to meet the requirements for a graduate degree in physical education, or which may enable some harassed faculty member to give the impression of being productive, but it will not contribute to our understanding of the conditions for muscle development.

(Submitted 9/29/59)

Strength Tests for Young Children—A Pilot Study[1]

JAMES E. TORPEY
Craig School
Niskayuna, N. Y.

BECAUSE STRENGTH TESTS have been used successfully for other age groups (and to some degree with elementary school groups) for the purposes of conducting research, establishing norms, and classification, this study was an attempt to determine the success with which a strength test could be conducted in a normal physical education class situation.

[1]Acknowledgment is expressed to Craig Elementary School, Niskayuna Public Schools, for support of this study and to fellow teacher James E. Andrews for his assistance in the collection and treatment of the test data.

The method used to measure the children's strength was Clarke's Cable Tension (1). Approximately 450 children were tested, using the leg extension test item. The leg extension test was chosen because of ease of testing. There was no discomfort on the child's part, and he was in a sitting position using a familiar movement. The right leg only was tested.

Prior to the testing each class watched a demonstration of the test. A discussion included why they were being tested, what muscles were being tested, meaning of the score, and ways of improving the score. Whenever possible, the children not being tested participated in another activity; otherwise, only a part of the class time was given over to testing. Two persons did most of the testing, but it was found that one person could do it. The time required to test an average class of 28 children was 60 minutes.

The means and standard deviations (see Table 1) showed a steady increase with grade level. For each grade, the boys' strength mean was larger than that of the girls; in most instances, their standard deviation was also larger. The high and low scores indicated that some first grade boys had stronger leg extension than did some sixth grade girls.

TABLE 1.—MEANS AND STANDARD DEVIATIONS FOR LEG EXTENSION STRENGTH[a]

Group	N	M	S.D.	RANGE
Grade one				
Boys	41	53	14	100-35
Girls	38	52	15	83-29
Grade two				
Boys	42	60	15	83-35
Girls	45	57	14	85-32
Grade three				
Boys	40	70	15	110-52
Girls	48	62	15	97-40
Grade four				
Boys	41	82	16	123-47
Girls	37	73	15	102-52
Grade five				
Boys	46	95	17	124-55
Girls	32	82	15	117-62
Grade six				
Boys	36	95	20	130-62
Girls	24	95	19	130-58

[a]Scores are expressed in pounds.

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(Submitted 4/29/59)

COMMENTS

Comments on the Selection of Data for Presentation

When selecting materials for presentation in a research article, the investigator must be guided not only by the need to support his conclusions but by the need to provide the reader with a basis for critical judgment. The omission of pertinent findings makes the critical reviewer skeptical, but more seriously it misleads the unwary reader. After reading a recent research article by Booth (1), I was not convinced that his conclusion was sound, and examination of the research as originally reported (2) indicated that the data might well support a contrary conclusion.

As a result of administering the MMPI to 286 Grinnell College students Booth (1) made the statement that:

". . . differences in personality as measured by the MMPI do exist between athletes and nonathletes and between participants in individual sports, in team sports, and in team-individual sports. Evidence has been presented which indicates that some items of the MMPI discriminate between athletes rated as poor and good competitors. Collectively, these results indicate that the MMPI has demonstrated merit as an instrument of measurement of personality traits of participants in program of physical education and athletics."

The materials to support this conclusion were an item analysis and seven one-way analyses of variance which displayed significance. Crucial in the evaluation of the materials presented seemed to be the answer to the question of how many nonsignificant analyses were found. This information was not in the research article, but from the primary report of the study it was discovered that there were 49 nonsignificant analyses. In 14 analyses of participants versus nonparticipants, four sets of differences were significant favoring alternately (a) lower-class and upper-class nonathletes, (b) upper-class athletes and nonathletes, (c) upper-class athletes, and (d) upper-class nonathletes. In 42 analyses of athletes variously grouped as freshman, varsity, team, individual, and poor or good competitors, only three demonstrated significance.

Assuming the establishment of a 5 percent level of significance, an investigator would expect that two of forty sets of randomly drawn data would demonstrate significance if submitted to statistical examination. The examination of another 40 sets of randomly drawn data would lead to the same expectancy. In the 42 analyses by Booth related to athletes, the three significant analyses should be treated with considerable suspicion until it is more fully demonstrated that the significance represents more than errors of chance.

In the 14 analyses of participants and nonparticipants the lack of direction and minimum achievement of significance would seem to indicate that readers should be cautioned regarding the value of such data for any general interpretations. As an additional observation, age appears to be as important a variable as particiption. This might suggest that differences noted in adolescent studies of participation disappear or are minimized when students reach early adulthood.

The sum of evidence from the two reports by Booth does not convince me "that the MMPI has demonstrated merit as an instrument of measurement of personality traits of participants in programs of physical education and athletics." The omission of pertinent information from the research report does demonstrate the care with which research authors must select findings for presentation to enable the reader to properly evaluate the findings.—*Jack Keogh, University of California, Los Angeles.*

References

1. Booth, E. G., Jr. "Personality Traits of Athletes as Measured by the MMPI." *Research Quarterly* 29: 127-38; May 1958.
2. Booth, E. G., Jr. *Personality Traits of Athletes.* Doctoral dissertation. Iowa City: State University of Iowa, 1957.

(Submitted 10/7/59)

Research Abstracts

Prepared by the Research Abstracts Committee of the Research Council, D. B. VAN DALEN, Chairman

44. BADGLEY, CARL E. "Sports Injuries of the Shoulder Girdle." *The Journal of The American Medical Association* 172; 444-48; January 30, 1960.

The author discusses the frequency and type of injuries likely to affect the shoulder girdle from participation in sports. He describes lesions that are likely to occur to the cervical and brachial nerves as well as how they occur. He discusses the recognition and diagnosis of acromio clavicular lesions and recommends treatment for the repair of both acute and chronic types.

The author asserts that good athletes are generally prone to have a higher incidence of dislocation of the shoulder joint. He attributes the increase in shoulder dislocations among good athletes to their increased fibroelastic diathesis. Fracture of the clavicle, injury to the sternoclavicular joint and bicipital tenosynovitis injuries are discussed and recommendations for their repair are made.

The author states that the reduced incidence of disabling shoulder injuries to athletes has been the result of better conditioned athletes and improved equipment.—*Carl S. Blyth.*

45. BAKER, PAUL T. "American Negro-White Difference in the Thermal Insulative Aspects of Body Fat." *Human Biology* 31: 316-24; December 1959.

Eighteen Negroes and 18 whites were matched for body weight, stature, and body fat. Body temperatures of the American Negroes showed significantly less variation than American whites. Significant correlations between adiposity and body temperature were found for both Negroes and whites. Since the American Negro soldier has substantially less subcutaneous fat than the American white soldier, representative samples should have shown the Negro-white rectal temperature difference greater than reported when both were placed in experimentally cold conditions. Although significant correlation was found, the majority of body temperature variation was not accounted for by subcutaneous fat, nor can it be explained by metabolic variations.—*D. B. Van Dalen.*

46. BARLETT, CLAUDE J. "Dimensions of Leadership Behavior in Classroom Discussion Groups." *Journal of Educational Psychology* 50: 280-84; December 1959.

A factor analysis of 300 phrases describing leadership behavior in classroom discussion group was done using the Wherry-Winer Method. The study was done to examine the dimensions of leadership behavior in a classroom group discussion situation. The analysis yielded four group factors and a large general factor. The general factor was interpreted as a general tendency to make high or low applicability ratings of the phrases on the basis of the halo effect. The four group factors were interpreted in terms of the ways which a group member can contribute to the group discussion: ideas and information, friendly atmosphere, labor and effort, policy and decisions.—*D. B. Van Dalen.*

47. BEHNKE, ALBERT R. "The Estimation of Lean Body Weight from Skeletal Measurements." *Human Biology* 31: 295-315; December 1959.

A comparison was made of lean body weight (LBW) estimated from "skeletal" measurements and from body density and total body water determinations on 31 male subjects. The correlations pertaining to this comparison were in the rate of .80 to .90. The higher correlations were obtained when both trunk and extremity dimensions were employed in the calculations. Variations in the amount of subcutaneous fat appeared to be responsible

for the largest source of error in estimates of LBW from the anthropometric measurements. The X-ray technique for measurements of joint diameters is satisfactory, but these measurements alone are not as highly correlated with LBW as are the combined trunk and extremity diameters. Complementary relationships were revealed for upper and low trunk and lower extremity measurements for men and women.—*D. B. Van Dalen.*

48. BOND, JESSIE A. "Analysis of Observed Traits of Teachers Rated Superior in Demonstrating Creativeness in Teaching." *Journal of Educational Research* 53: 7-12; September 1959.

The entire enrollment of 855 student teachers in one year at the University of California at Los Angeles were found as a group to rate next to the lowest of 32 traits in creativeness. Of this enrollment, however, 87 of the 266 elementary student teachers and 158 of the 589 secondary student teachers were rated superior in this quality. In this study, comparisons were made between the highly creative students and the 855 unselected students on the basis of mean scores obtained on all 32 traits.

Mean scores for the creative group were higher on all 32 items than the unselected group of 855. The conclusion seemed justified that creativeness is essential as a contributor to superior teaching success and that it is proportionately lacking with teachers of inferior ability.

The rank order of 32 traits disclosed significant differences between the creative and less creative groups. Chief among these were "resourcefulness" and "initiative" which characteristics appeared much higher in rank with both elementary and secondary creative teacher than they did in the list of the unselected group.

Since creativeness appears to be one of the distinguishing differences between the fair and the outstanding teacher, teacher education institutions should lay heavy stress on this factor in the process of preparing teachers.—*Vera Skubic.*

49. BRASHEAR, ROBERT G. "Basic Areas of Prevention of Athletic Injuries." *The Journal of The American Medical Association* 171: 140-41; November 21, 1959.

The author lists three basic areas of prevention of athletic injuries. Selection of a responsible and level-headed coach comes first; as leader, teacher, and purchaser-fitter of protective equipment, the coach always shoulders a major share of the responsibility for the prevention of injury. Another area of prevention is that of the team physician; the use of such an official as an organizer of program as well as a healer of injuries is encouraged. The qualified athletic trainer on the high school level is offered as the third basic area. The National Athletic Trainers Association has recommended a college curriculum consisting of a major in physical education and a minor in one of the basic sciences for the development of qualified teacher-trainers. Such an individual could teach in the classroom in addition to performing the regular duties of an athletic trainer, thus lightening school budgetary problems involved in his hiring.—*Carl S. Blyth* and *W. C. Taylor, Jr.*

50. BRISKEY, E. J., and others. "The Effect of Various Levels of Exercise in Altering the Chemical and Physical Characteristics of Certain Pork Ham Muscles." and "The Effect of Exhaustive Exercise and High Sucrose Regimen on Certain Chemical and Physical Pork Ham Muscle Characteristics." *Journal of Animal Science* 18: 146, 173; February 1959.

The authors found that all the muscles in a group, which normally work together in performing an action, do not all show the results of that work. In the group comparable to human gluteals, only the largest muscle in the group reacted as we assume a muscle would after it has been used. Unless we can find an explanation for this I'm afraid that we can no longer speak of "pectorals" or "hamstrings." We will have to be very certain that the particular muscle we want to use, or keep rested, is considered separately.—*Nar Bracker.*

51. British Medical Journal. "Steely Eyes and Pain." *British Medical Journal* 5149: 418; September 12, 1959.

There exists an obvious difference in the pain reaction of individuals when subjected to the same stimulus. Sutton has found that reaction to pain is related to the color of the eyes. As the color goes through blue, blue-grey, green, hazel, light brown, and dark brown, reactions to pain tend to increase. No explanation of these findings is available.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

52. Chiles, W. Dean. "Effects of Elevated Temperatures on Performance of a Complex Mental Task." *Ergonomics* 2: 89-96; November 1958.

Eleven subjects were tested on a complex mental task consisting of identifying differences in card symbols during one-hour exposures to four different dry bulb/wet bulb temperature conditions: 85 deg./75 deg., 90 deg./80 deg., 95 deg./85 deg., and 100 deg./90 deg. F. In a second experiment, ten subjects were tested at 85 deg./75 deg., 90 deg./80 deg., 110 deg./90 deg., and 120 deg./90 deg. F. In both experiments, differences in performance among the temperature conditions were small and not significant.—*David H. Clarke.*

53. Collier, Clarence C., and others. "Syndrome of Extreme Obesity and Hypoventilation: Studies of Etiology." *Annals of Internal Medicine* 51: 541-52; September 1959.

This study was conducted in an attempt to identify the underlying causes of hypoventilation in extremely obese individuals. Since hypoventilation and polycythemia were found to occur in obese persons with no antecedent history of heart or lung disease, it was hypothesized that some functional abnormality connected with the obese condition was responsible for the resultant hypoventilation. To test this hypothesis, the abnormalities related to extreme obesity were duplicated experimentally by binding both the chest and abdominal walls of ten medical students selected as a control group. Under these experimental conditions, the control students developed abnormal pulmonary functions characterized by an increase in intra-abdominal pressure, pleural pressure, and airway tissue resistance and a decrease in vital capacity, compliance, and maximum breathing capacity. These abnormal conditions were similar to those experienced by 17 extremely obese patients.—*Carl S. Blyth* and *John Burt.*

54. Crowley, Francis J. "Compensation of Subjects for Participation in Research." *School and Society* 87: 430-31; October 24, 1959.

The subjects for this study were 44 vocational high school teachers and 169 academic high school teachers from nine New York City public schools. In seven schools, each subject received two dollars for the time spent on the checklist. Subjects in two of the schools were not paid and subjects in one paid school did not know about the payment until the checklists were all completed and returned.

A summary of the checklist responses was then sent to the participating teachers, as well as a stamped, addressed postal card for the teacher to return, with or without comments.

In the nonpaid schools, including the uninformed school, 78 checklists were distributed and 62 (79%) were returned initially. A personal follow-up increased the returns to 65 (83%). The paid teachers returned all 148 of the distributed checklists. The difference between these percentages of return was significant beyond the .01 level. Of the nonpaid returns, 59 (90.8%) were usable, while 146 (98.6%) of the paid returns were usable, the difference significant at the .01 level.

Seven (16.7%) of the commentary cards were returned from the nonpaid schools and 42 (28.4%) from six of the paid schools. This difference was not statistically significant.

On the basis of the data, it seemed proper to conclude that payment of the teacher subjects for their time had a significant effect on the number of checklist returns and on the cooperation of the subjects.—*Martha J. Haverstick.*

55. CUSHMAN, WESLEY P., and BENNETT, BRUCE L. "A Health Problem Check List." *Journal of Health, Physical Education, Recreation* 30: 28-29+; December 1959.

A check list of specific health problems common to high school seniors and college freshmen was devised by submitting a list of problem questions on various health topics to 414 students. Four groups were used: 79 boys and 87 girls in two high schools, a suburban and a rural school; 81 college women at Ohio State University and a private denominational college; and 167 college men at Ohio State University. A numerical score was computed for each question by assigning point values for the degree of importance of the question as indicated by the students. The scores were used to eliminate questions of little importance as well as similar questions. The final check list of 96 problem questions can be completed by students in half an hour. In addition to helping the teacher plan what health units to include and omit, the check list can also provide a knowledge of specific problems of high interest within a unit.—*Martha J. Haverstick.*

56. DANOWSKI, T. S., and WRATNEY, M. J. "Age and Sex Related Muscle Weakness." *Archives of Physical Medicine and Rehabilitation* 40: 516; December 1959.

The performance of various muscle groups against gravity and resistance was tested in a total of 160 normal male and female subjects. Results indicate that during the 7-15 year period both males and females exhibit relative weakness in the muscles of the pelvic and extrapelvic group. From 16 years on, males attain maximal strength in all muscle groups, but a significant number of females between 15 and 30 show a weakness of the hip flexors, hip rotators, hip extensors, and the gluteus medius. Therefore, such age-sex differences should be taken into account in tests of muscle performance. It is suggested that such differences may be related to androgen-estrogen secretion.—*Lora M. Ewing* and *Peter V. Karpovich.*

57. DELANNE, R., and others. "Changes in Acid-Base Balance and Blood Gases During Muscular Activity and Recovery." *Journal of Applied Physiology* 14: 328; May 1959.

In this study, six male and six female subjects rode bicycle ergometers for 30 minutes with submaximal work load followed by a sprint of maximal work under three environmental conditions: usual room conditions, simulated desert conditions, and simulated sub-tropical conditions. It was found that the venous oxygen level decreased during the early minutes of exercise, but later, during submaximal exercise and also at the end of maximal effort, it increased, the amount of this increase depending upon ambient conditions. Venous CO_2 content decreased with exercise, the amount being influenced by both sex and ambient condition. The amount of lactic acid in the blood at rest did not vary with environment or sex, but changes in lactic acid content during exercise were always more marked in the female than in the male, and lactic acid content was affected more by the intensity than by the duration of exercise. Changes in pCO_2, plasma volume, buffer bases, and pH of blood, were also reported.—*Lora M. Ewing.*

58. DIECKMAN, D. "A Study of the Influence of Vibration on Man." *Ergonomics* 1: 347-55; August 1958.

The effects of vertical and horizontal mechanical vibrations up to 100 cycles per second on a human being were examined by physical and physiological methods. Resonance phenomena are described. A strain scale is given for vertical and horizontal vibration excitation. Special examinations of the movement of the head show elliptic vibrations in spite of linear excitation. Vibration measurements in a rail-motorcar provide an example for typical resonance phenomena of the mechanical system formed by a 'man sitting on a seat.'—*David H. Clarke.*

59. GRIMALDI, JOHN V. "Sensori-Motor Performance Under Noise Conditions." *Ergonomics* 2: 34-43; November 1958.

A coordination task was performed in quiet and noisy environments, the noise being intermittent, within the frequency range of 75 to 9600 cycles and at sound levels of 70, 80, 90, and 100 db. There was a tendency for more errors and less precision when working in the noisy environment. Response times were slower and the number of errors greater when noise levels and frequencies were highest. The frequency range of 2400-4800 cycles was associated with the slowest response time and largest number of errors, both at 90 and 100 db. Apparently intermittent noise may have a reducing effect on the individual's capacity for quick and precise execution of coordinated movements.—*David H. Clarke.*

60. HALE, CREIGHTON J. "What Research Says About Athletics for Pre-High School Age Children." *Journal of Health, Physical Education, Recreation* 30: 19-21+; December 1959.

Sociological, psychological and physiological investigations were reviewed as to the effect of athletic competition upon pre-high school age children.

Physiological measurements are highly variable in this age group. However, research indicates that a normal heart cannot be injured by strenuous physical activity; the heart and arteries do develop at the same rate; and that the rate of maturation of athletes exceeds that of nonathletes. Young children on the team should be equated according to maturation levels.

Sociological and psychological findings indicate that children who participate in competitive athletics exhibit greater popularity, social esteem and acceptance, personal and social adjustment, broader interests, with superiority in cooperation, friendliness, integrity, leadership, critical thinking, and in total adjustment scores. Parents responded with marked unanimity as to the benefit of interscholastic-type athletics.

Various medical opinions were presented in the report. These included the divergent opinions of orthopedists as to the prevalence of epiphyseal injuries in the 12-15 age group, as well as the desirability of boxing and football.

The review of research indicates that pre-high school age children benefit from interscholastic athletic experience, physiologically, psychologically, and sociologically. Research on the effect of interscholastic athletic activities upon young children is incomplete. Longitudinal studies are needed, as well as data on sport injuries, emotional responses, and the effect of athletic participation upon girls.—*Martha J. Haverstick.*

61. HOON, JAMES B. "Adductor Muscle Injuries in Bowlers." *Journal of the American Medical Association* 171: 2087; December 12, 1959.

The author reports three cases of injury to adductor muscles while bowling, involving strain, and in one case actual avulsion of muscles of adduction of the thigh. All three injuries resulted from suddenly stopping in an awkward position as may happen during braking at the foul line on delivery of the ball. As in the prevention of all athletic injuries, the importance of proper conditioning and training is emphasized, and it is suggested that this specific type of injury can be prevented by an altered approach to the foul line and by following through rather than violently braking.—*Lora M. Ewing* and *Peter V. Karpovich.*

62. HUMPHREY, JAMES H. "Reading and Physical Education." *Journal of Health, Physical Education, Recreation* 30: 30-31; May-June 1959.

This article appeared as a summary of a paper presented at the Research Section of the 60th Convention of the AAHPER. Three pieces of research were cited. One piece of research involved 54 reading groups of primary school children aged six to eight. Ten games were written in story form by the investigator and later read by the children.

They then organized and played the games on the basis of their reading. Forty-six percent of the children showed "extreme" interest in the reading, 24 percent "considerable" interest, and 0.3 percent "little or no" interest. The investigator concluded that the children had a genuine purpose for reading—to play and to learn a new game.

A second study used the same stories in order to determine their value as independent reading material. The stories were compared with other independent reading for primary children. Sixty-four percent of the teachers compared them more favorably, while 36 percent less favorably.

The third study reviewed here explored the possibilities of integrating physical education activities and reading vocabulary words with a selected group of 30 third-grade children. The subjects were given a reading vocabulary test on words from their reader at the beginning and end of a two-week experimental period. Both experimental and control groups had the same reading lessons and physical education lessons, with the addition in the experimental group of integrating words used in the experiment as a part of the physical education lessons. No statistically significant differences were found between the control and experimental groups. However, 73.3 percent of the subjects in the experimental group improved on the second vocabulary test as compared to 46.6 percent of the control group.—*Martha J. Haverstick.*

63. Journal of the American Medical Association. "Athletic Injuries." *Journal of the American Medical Association* 171: November 21, 1959.

Attention is called to the November 21, 1959 issue of *The Journal of the American Medical Association* in which appear six articles dealing with athletic injuries. Three of these will be of particular interest to physical educators, coaches, and trainers: "General Principles in Treatment of Injuries to Athletes," "Basic Areas of Prevention of Athletic Injuries," and "Athletic Training, Protective Equipment, and Protective Support." The other three articles deal with specific injuries to the shoulder and knee.—*Lora M. Ewing.*

64. Kazuo, Asahina, and others. "Influences of Excessive Exercise on the Structure and Function of Rat Organs." *Japanese Journal of Physiology* 9: 322-26; September 15, 1959.

Rats were exercised by a method which required forced swimming. Under light or moderate exercise the sexual cycle regularly appeared, but heavy exercise severely disturbed this cycle and caused a long lasting anestrus. This same effect has been observed in the human. The adrenal cortex at first hypertrophied, but later general degenerative changes and atrophy were observed. A marked picture of atrophy was also seen in the thymus, but few changes were found in the salivary glands or the testicles. Histological changes in the intestines and kidneys were very severe for their comparatively slight functional disturbances. Atrophy or degeneration appeared earlier in the castrated groups, suggesting the sexual hormone may have some important role in training.—*P. J. Rasch, Journal of the Association of Physical and Mental Rehabilitation.*

65. Kilander, Frederick H. "A Survey of the Public's Knowledge of Certain Aspects of Human Reproduction." *The Journal of School Health* 29: 211-15; June 1959.

The article reports information obtained from the Health Knowledge Test which was begun in 1935. The results of the testing indicated:

1. The public—high school students, college students, and adults of various socioeconomic groups—are not adequately informed about human reproduction and hold numerous misconceptions in this area.

2. There has been a slight but continuous improvement in the level of information during the past 25 years.

3. Male high school and college students tend to be slightly better informed about the anatomy and physiology of their own sex than are the female students about their own sex.

4. Male students also tend to be slightly better informed on the questions asked about the opposite (female) sex than the female students are about the opposite (male) sex.

5. Adult groups who have had no education beyond the high school level, or who in college had no biological or health instruction, tend not to score as well as today's college freshmen.

6. Young parents with a high school and college education are better informed in regard to sex education and have a more wholesome attitude toward the subject—*Hollis F. Fait.*

66. KLOCKE, F. J., and RAHN, H. "Breath Holding after Breathing of Oxygen." *Journal of Applied Physiology* 14: 689; September 1959.

Tests carried out on seven untrained subjects who held their breath as long as possible after maximal inspiration of air and of oxygen, showed an increase in holding time from a range of 3.1-8.5 minutes after inhaling room air to a range of 6-14 minutes after inhaling oxygen. Surprisingly, the total amount of CO_2 found in the lungs at the end of breath holding, whether preceded by O_2 or air inhalation was within a few milliliters of the volume at the beginning of breath holding. The breaking point CO_2 alveolar tension after oxygen breathing did not exceed that after air inhalation although the time was longer. Therefore, changes in lung volume can be attributed to uptake of O_2 alone. Three subjects absorbed their entire vital capacity during breath holding. After 13 minutes, the average lung volume (average vital capacity taken as 3820 m. STPD) will be reduced to the residual volume.—*Lora M. Ewing* and *Peter V. Karpovich.*

67. KRAUS, HANS; NAGLER, WILLI; and WEBER, SONYA. "Role of Exercise in the Prevention of Disease." *G.P.* (American Academy of General Practice) 20: 121-26; September 1959.

Many orthopedic disabilities and neuromuscular tension syndromes are due to underexercise. Compared to the under-exercised person, the well-exercised has low neuromuscular tension, low absolute and relative weight, low blood pressure, low pulse rate, greater adrenocortical reserve, greater muscle strength and flexibility, and greater vital capacity. Coronary heart disease, duodenal ulcer, and diabetes are more prevalent among the inactive. There is considerable interaction of physical fitness and emotional stability. The state of under-exercise increases with the increase of mechanization and the problem of inactivity becomes more urgent. The general practitioner should appraise muscle status as part of his general check-up.—*P. J. Rasch, Journal of the Association of Physical and Mental Rehabilitation.*

68. LEHMAN, G. "Physiological Measurements as a Basis of Work Organization in Industry." *Ergonomics* 1: 328-44; August 1958.

The measurement of the work load in industry necessitates the use of reliable methods and of apparatus which is easy to handle in the factory environment. Three methods suggested are (1) an exact time study covering the whole working day and including details of all accessory operations and all rest pauses, (2) the measurement of energy cost of work by the use of the respirometer developed at the Max-Planck Institute, and (3) the measurement of pulse rate by means of the Muller pulse counter. A number of examples are quoted of the use of these methods in several forging shops and in a motor car factory, which include instances of underloading and overloading of the worker. The reasons and remedies are also discussed.—*David H. Clarke.*

69. MALHORTA, M. S.; SHARMA, B. K.; and SIVARAMAN, R. "Requirements of Sodium Chloride During Summer in the Tropics." *Journal of Applied Physiology* 14: 823-28; September 1959.

Twenty-four Indian subjects acclimatized to the heat were tested at New Delhi during June and July to determine salt requirements in the tropics. The subjects were required to march at a speed of 3.5 m.p.h. in the open sun for two hours daily for 6-8 days. The daily observations made were as follows: (1) body weight was taken as fasting weight each morning; (2) sweat was collected from the left arm by enclosing it in a plastic

bag tied to the shoulder for the duration of the experiment; (3) urine was collected immediately after the two-hour experiment, again at the two- and four-hour marks after termination of the experiment, and finally, the following morning; and (4) environmental temperature during the experiment was taken from readings of the wet and dry bulb temperatures as well as recording of the maximum temperature of the day as observed by a nearby meteorological station.

The authors show that the minimum salt requirement under the experimental conditions is 6.2 gm. per day. Furthermore, they state that 14.3 gm. of salt intake per day will suffice for eight hours' work in the normal environment prevailing in their country. The authors point out that if mean urinary chloride excretion is 3.88 gm. per day or more, there is no likelihood of any salt deficiency. They found that on a salt intake of 16.2 gm. per day with no restriction on water the mean daily urine excretion was .84 liters. This value is somewhat lower than that reported by other investigators. However, this study supports the findings of other investigators who have concluded that more importance be attached to the total daily chloride excretion in urine than to its daily volume.—*Carl S. Blyth.*

70. Mathis, Claude. "The Relationship Between Salary Policies and Teacher Morale." *Journal of Educational Psychology* 50: 275-79; December 1959.

Personnel in ten suburban school systems were given an attitude inventory designed to measure level of morale. The inventory was administered for the purpose of determining what differences in level of morale, if any, existed between schools which use a merit type salary schedule and schools which use a nonmerit type salary schedule. No significant difference in morale level was found between schools grouped on the basis of type of salary schedule. A significant difference in level of morale was found among the ten schools involved in the sample. No significant differences in indication of morale level were found between areas of the attitude inventory, suggesting that individuals within each school tended to approach the inventory as a whole rather than projecting differential feelings of morale into specific areas of the inventory.—*D. B. Van Dalen.*

71. Maul, Ray C. "Future Demand for Teachers in Health and Physical Education." *Journal of Health, Physical Education, Recreation* 30: 40; September 1959.

The annual nationwide study of the teacher supply-demand problem by the NEA Research Division provided the following information: 1950 saw the greatest supply of men trained to teach health and physical education; in 1951-1954 an abrupt decrease in the supply of men was shown; 1954-1959 showed a steady increase in the supply of men teachers. As to the supply of women teachers, 1950-1954 saw a decrease in supply of graduates although not as great as in the case of the men; in 1954-1959 an increase was seen but not as large as the increase of the men. It was also noted that men with an emphasis in mathematics and/or science training in addition to health and physical education will find more opportunities for employment than those without such versatility.—*Martha J. Haverstick.*

72. Medley, Donald M., and Mitzel, Harold E. "Some Behavioral Correlates of Teachers Effectiveness." *Journal of Educational Psychology* 50: 239-46; December 1959.

Five measures of effectiveness and three measures of classroom behavior were obtained on 49 beginning teachers in New York City public elementary schools, and analyzed with statistical controls on differences between schools and differences between classes within schools. The five measures of effectiveness were found to center around two distinct aspects of effectiveness. Supervisory ratings and pupil's reactions to their teachers appeared to reflect the teacher's ability to get along with children; teachers self-ratings and measures of pupil gains appeared to reflect effectiveness in stimulating pupils to learn to read. Pupil-teacher rapport was found to be related to emotional climate and, probably, to verbal emphasis in classroom behavior. Supervisors rated those teachers

who had the friendliest classrooms as most effective. Teachers who rated themselves most effective in teaching fundamental skills tended to allow their pupils less opportunity to work in small, autonomous social groups.—*D. B. Van Dalen.*

73. MONTEBELLO, ROBERT A. "Should Physical Education Be Required During the Undergraduate Program?" *Journal of Health, Physical Education, Recreation* 30: 35-36+; December 1959.

Five case studies were made of institutions in which reviews had been made of the physical education requirement. The interview technique was used to obtain information as well as published documents, minutes of meetings, and letters. Basic issues of concern were grouped as follows: time spent in physical education class rather than academic work; requiring rather than electing physical education when other subjects are not required; scheduling problems; poor teaching; and lack of medical benefit of required physical education. Four of the five institutions were able to present arguments strong enough to retain their requirements.—*Martha J. Haverstick.*

74. NASS, MARTIN L. "Characteristics of a Psychotherapeutically Oriented Group for Beginning Teachers." *Mental Hygiene* 43: 562-67; October 1959.

The author, a clinical psychologist, met with six women elementary school teachers in their first year of teaching for a series of 32 sessions to discuss their problems of adjustment. Four major areas came up for discussion—relationships with authority, expectations of self, relationships with colleagues, relationships with children. Many of the problems reflected basic personality factors and problems of conscience.—*Bruce L. Bennett.*

75. O'DONOGHUE, DON H. "General Principles in Treatment of Injuries to Athletes." *The Journal of the American Medical Association* 171: 132-35; November 21, 1959.

This article defines the role of the physician in the treatment and prevention of athletic injuries and presents the physician's responsibility in the development of a sound athletic program. The value of an athletic program is discussed and the salutary effects of athletics upon the character of the participants are pointed out.

In the treatment of athletic injuries the author suggests that the physician recognize the value of competitive athletics. He should avoid undue pressure from individuals who want the athlete to return too early to practice after injury. The author further suggests that the attending physician adopt the best method of treatment for the injury, and realize the importance of prompt treatment. A final point by the author stresses the importance of an athlete being completely recovered from his injury before being allowed to participate again.—*Carl S. Blyth.*

76. PAGAN-CARLO, JOSUE. "Vascular Measurements of Smokers and Nonsmokers." *Journal of the American Medical Association* 171: 2182; December 19, 1959.

Micrometric measurements performed by means of vernier calipers calibrated to 1/1000 in. were made of the vascular shadows in the right middle and lower lobes on chest roentgenograms of 694 asymptomatic smokers and nonsmokers. A statistically significant difference was found in the size of the main hilar vessels, i.e., 0.533 in. for smokers and 0.664 in. for heavy smokers (more than 30 cigarettes daily). It is postulated that this is due to a hypotrophic dilatation in response to continued vasoconstriction initiated by nicotine.—*Lora M. Ewing* and *Peter V. Karpovich.*

77. PEARSE, INNES H. "Steely Eyes and Pain." *British Medical Journal* 5154: 160; October 17, 1959.

Changes in the color of the eye can accompany anxiety states as well as pain (see No. 51). In the case of a certain pulmonary tuberculosis patient, this markedly blue-eyed woman developed gray eyes as the time for a medical check-up approaches. After the examination her eyes immediately regain their blueness.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

78. PEPLER, R. D. "Warmth and Performance: An Investigation in the Tropics." *Ergonomics* 2: 63-88; November 1958.

Three experiments on manual tracking (N = 16 — 32), one on prolonged visual watchkeeping (N = 18), and one on high speed decision taking (N = 24) were conducted in Singapore to study the effects of unusual levels of environmental warmth on the performance of skilled tasks by young European men living in the tropics. In general, the results substantiated previous research showing that young men living in a temperate climate performed skilled tasks less efficiently in unusually warm conditions. Performance first deteriorated somewhere between about 81 deg. and 86 deg. F. on the effective temperature scale, although there was some evidence that the critical region was lower for warm humid climates than for warm dry ones. The subjects at Singapore appeared to be somewhat more disturbed by unusually cool climates than was true previously of artificially heat acclimatized men in England.—*David H. Clarke.*

79. PHILLIPS, MARJORIE; FOX, KATHARINE; and YOUNG, OLIVE. "Recommendations from Women Doctors and Gynecologists about Sports Activity for Girls." *Journal of Health, Physical Education, Recreation* 30: 23-25; December 1959.

Eight gynecologists and nine women physicians completed a check list regarding the recommended activity for girls and women who experience "no," "moderate," and "considerable" premenstrual discomfort and/or dysmenorrhea. The questions on the check list were related to participation of girls and women in vigorous physical exercise, intensive sports competition, and swimming (from a health standpoint rather than sanitary) during the menstrual period. The period was divided into three phases: the premenstrual period, the first half, and the second half of the menstrual period.

There was very little difference shown in the recommendations of the gynecologists and physicians, although when a difference did occur, the women physicians were consistently more conservative in their views. For all types of girls the strongest recommendation for moderation in all forms of activity was during the first half of the menstrual period, followed by the premenstrual period. The large majority of doctors place no restrictions on physical activity, sports competition, and swimming during any phase of the menstrual period when free from menstrual disturbances. For girls and women who experience premenstrual discomfort, the restrictions increase as the severity of the discomfort increases.—*Martha J. Haverstick.*

80. RASCH, PHILIP J. "Endurance Training for Athletes." *Journal of the Association for Physical and Mental Rehabilitation* 13: 182-85; November-December 1959.

The development of endurance is discussed under three general topics: reducing energy expenditure by increasing the efficiency of movement, increasing the oxygen transport, and developing a resistance to the discomforts associated with fatigue. In addition, current theories of developing endurance are included, such as fartlek training, interval training, circuit training, and repetition training. It was generally concluded that endurance is brought about by working at progressively increasing work loads for extended periods of time.—*David H. Clarke.*

81. RAWLINSON, KENNETH B. "Athletic Training, Protective Equipment, and Protective Support." *The Journal of The American Medical Association* 171: 146-48; November 21, 1959.

The duties of the athletic trainer are classified by the author into three categories: (1) prevention of injuries, (2) treatment of injuries, and (3) rehabilitation of the injury and the athlete as a whole.

The three major topics listed above are subdivided as follows with an accompanying discussion. 1. Prevention: (a) physical examination, (b) physician on the bench at every contest, (c) maintenance of a good practice field, (d) physical and mental conditioning of the squad, (e) good equipment, (f) special pieces of equipment to protect a special injury, and (g) preventive and protective taping. 2. Treatment of injuries: the author makes the point that this is a minor part of the trainer's job. Trainers, he says,

are coordinators between coach and physician, and are "suspecticians" who rely on the physician for diagnosis. 3. Rehabilitation: the points made here are (a) that the trainer work hand in hand with the physician, (b) that rehabilitative exercises be started as soon as possible after injury, and (c) that surgery for the high school athlete who needs it be done before he reaches college.

A brief summary of methods of prevention and protective strapping used at the University of Oklahoma is presented. In addition to this, protective equipment, protective support, and improvements in equipment are discussed. Mr. Rawlinson's ideas are presented in a clear and appealing style. The presentation leaves no doubt in the reader's mind that the athletic trainer is an important part of the total athletic program.—*Carl S. Blyth* and *Bill W. Lovingood.*

82. Recreation Management. "Bowling Survey." *Recreation Management* 2: 10-11; April 1959.

The National Industrial Recreation Association conducted a spot check of 220 companies representing both large and small firms throughout the U. S. and Canada as to the 1958-59 industrial bowling season. In this survey, 98,439 men, women, and children participated in bowling. Problems confronting industrial bowling were lack of good facilities, policies on length of season and fees, and the uncooperative attitudes of some bowling proprietors. Bowling centers are selected according to four major factors, listed in rank order of responses: majority vote of bowlers, availability of lanes, league officials, and location. Bowling participation was promoted by: the company paper, bulletin boards, and personal contact. The length of reason ranged from 17 weeks to a full year, the 32-week season being the most popular. Fee per lane ranged from 25 cents or less to 75 cents, a 45 cent fee being reported most frequently. More bowling is done at public bowling centers than at company lanes. Approximately 60 percent of all industrial bowlers own their own balls.—*Martha J. Haverstick.*

83. Recreation Management. "Newcomer to 'Top Ten.'" *Recreation Management* 2: 36; May 1959.

Travel, both foreign and domestic, is increasing in popularity as a recreational activity in industry. Travel's popularity in 1959 should place it approximately sixth on the list of activities; horseshoes and bridge have steadily declined in popularity for the past ten years. Rifle and pistol shooting are also increasing in popularity. Foreign trips were scheduled during vacation or plant shutdown periods with an average cost of $609 per traveler for a period of three weeks. The cost included tour, meals, and transportation.—*Martha J. Haverstick.*

84. Roberts, D. F.; Povins, K. A.; and Morton, R. J. "Arm Strength and Body Dimensions." *Human Biology* 31: 334-43; December 1959.

The mutual association of arm strength, arm morphology, and body size was examined and three factors were isolated to account for the greater part of the variance. A general size factor common to all the dimensions was found to extend also to the strength measurements. A second bipolar factor, in morphology contrasting length with girth, appeared to distinguish elbow strengths from grip strengths; it was suggested that this was partially attributable to differences in technique of measurement. The effect of body size and limb dimensions, especially the arm girths, on arm strength was clearly established.—*D. B. Van Dalen.*

85. Schenthal, Joseph E. "Multiphasic Screening of the Well Patient." *Journal of the American Medical Association* 172: 1-4; January 1960.

Multiphasic screening examinations were given to 10,709 asymptomatic and apparently healthy individuals who had not been examined by a physician for six months. The examinees were both male and female and represented a wide age range (10-89) and socioeconomic level. The examinations were conducted by the Tulane University Cancer

Detection Clinic, over the 12-year period, 1946 to 1958. Of these 10,709 subjects, 92 percent were found to have either organic or functional diseases. Cases of heart disease numbered 804 and 77 cases of malignancies were detected. The remaining abnormalities were accounted for in the following manner: gynecologic disorders were detected in 65.3 percent of the examinees, gastrointestinal disorders in 21.3 percent, and genitourinary tract disorders in 6.2 percent. The results of this study indicate the importance of systematic and regular health examinations, and point out the frequency of certain disorders among the various age groups.—*Carl S. Blyth.*

86. SENDROY, JULIUS, JR., and CECCHINI, LOUIS P. "Indirect Estimation of Body Surface Area and Volume." *Journal of Applied Physiology* 14: 1000-1004; November 1959.

A photographic technique of obtaining anthropometric data to be used for the calculation of human body surface area is described. From standard somatotype negatives front and side views of 21 individuals were outlined in silhouette, measurements were made with a photoelectric area-meter, and a correction made for photographic reduction. Surface area values in square meters were obtained by multiplying two times the sum of the anterior view area and the lateral view area. Results were in close agreement with other reliable measures of surface area.

Six empirical equations for determining body volume from measurements based on height and weight are discussed. These equations were derived by the authors and tested with data gleaned from the literature. Although less exact than existing equations based on the determination of body density, these formulas, all of which assume density to be a constant, may be superior from the viewpoint of convenience and speed.—*Carl S. Blyth.*

87. SEXTON, PATRICIA CAYO. "Social Class and Pupil Turn-Over Rates." *Journal of Educational Sociology* 33: 131-34; November 1959.

The author made a study of elementary schools in a large Midwestern city to determine the number of students who entered or left school during the semester. She found that the rate in low income areas was 59.6 percent of the total school membership. The rate for the highest income group was only 13.1 percent. Her study also revealed that losses from school due to illness were twice as high for the lowest income group as for the highest. The writer discusses the implications of these data for the schools. She suggests that teachers in low income schools should have smaller classes than those in the high income schools so that they can give these students more attention.—*Bruce L. Bennett.*

88. SIMON, MARIA D. "Body Configuration and School Readiness." *Child Development* 30: 493-510; December 1959.

Paper consisted of two separate but related cross-sectional studies. In the first study, based on 90 Caucasian children from higher socioeconomic levels, it was found that there is a striking change in body configuration between the ages of 4-6 and 7-9. Judges discriminated three types of body figures—early, intermediate, and middle childhood figures. The identification of the change in configuration was shown not to depend upon age, sex, or particular aspects of the head of body alone.

In the second study, based on 50 failing and 50 top Caucasion students in the first grade, drawn from all socioeconomic levels, it was found that failing students tended to be more immature on a battery of anthropometric indices than successful students. This difference did not depend entirely on age or IQ, since failing students matched for age and IQ with the top students were also found to be more immature. Of the measures studied, head circumference/leg length and waist circumference/leg length were the most sensitive indicators of school readiness.—*D. B. Van Dalen.*

89. SLOAN, A. W. "A Modified Harvard Step Test for Women." *Journal of Applied Physiology* 14: 985; November 1959.

A group of healthy female physical therapy students, age 17-21 years, was given the Harvard Step test with bench heights of 20, 18, and 16 in. and the results compared with

those from a group of 46 male medical students of comparable age using a 20-in. bench. Results of tests on the 18-in. bench correlated best with results of men, so another group of 16 women medical students of same age group were tested with 18-, 17- and 16-in. benches and these results compared with the men's scores. Closest agreement with the men's scores was found between the indexes of the group performing on the 17-in. bench. Applying X^2 test to two-way contingency tables obtained by comparing men and women medical students in the three fitness categories—poor, average, and good—there was excellent agreement between men tested on a 20-in. bench and women using the 17-in. bench. Therefore, when a 17-in. bench is used, the same standards of performance may be applied to women with the same validity as to men using the standard bench.—*Lora M. Ewing* and *Peter V. Karpovich.*

90. Sproule, B. J., and Archer, R. K. "Change in Intravascular Temperature During Heavy Exercise." *Journal of Applied Physiology* 14: 983; November 1959.

Brachial artery, brachial vein, and femoral vein temperatures were measured in five young subjects before, during, and after a 2.5 min. treadmill run. The investigation was undertaken in an attempt to explain a previously observed shift to the right in the oxygen dissociation curve during treadmill running. Although a mean temperature rise of 0.67 deg. C. was recorded from the femoral vein and a 0.49 deg. C. rise from the brachial artery and vein, these changes were insufficient to explain the shift in the oxygen dissociation curve. The observed increase in temperature (0.67°C.) theoretically would cause pO_2 content of blood to increase 2.5 mm. Hg. more than a value calculated from the reference oxygen dissociation curves in the *Handbook of Respiratory Physiology.—E. R. Buskirk.*

91. Stuart, Douglas G., and Collings, W. D. "Comparison of Vital Capacity and Maximum Breathing Capacity of Athletes and Nonathletes." *Journal of Applied Physiology* 14: 507; July 1959.

Twenty athletes on various varsity teams engaged in competition and 20 medical students (no regular exercise or manual labor for two years) were paired as to age, height, weight, and body surface area, and tested for vital capacity (VC) and maximum breathing capacity (MBC). Results showed that the athletes had a significantly higher vital capacity than the nonathletes, but the difference between the maximum breathing capacity of the two groups was not statistically significant. It is suggested that the greater VC of the athlete is the result of greater development of respiratory musculature. A MBC test may be of value in detecting defective ventilation capacity but is of little value in assessing superior capacity. Most subjects experienced discomfort between the sixth and 12th seconds of hyperventilation and felt that 12 seconds was about the upper limit of really maximum voluntary breathing. The authors also stressed the need for standardization of testing procedures and apparatus in MBC tests before valid comparisons of such measurements can be made.—*Lora M. Ewing.*

92. Stunkard, Albert. "Physical Activity, Emotions, and Human Obesity." *American Practitioner and Digest of Treatment* 10: 1500-1501; September 1959.

Psychiatric investigation of obesity has traditionally focused on eating disorders; the current study attempts to measure physical activity. Fifteen obese women were matched with fifteen nonobese women. Each carried a pedometer for one week. Attitudes toward activity were measured by a direct questionnaire and by a sentence-completion test. The obese women walked less than half as far as the nonobese and exhibited sharply different attitudes. The determinants of physical activity appear to be biologic (physical illness, injury, environmental temperature, food intake, and the phase of the female reproductive cycle), social (week-day activities, occupation, and transportation), and emotional. Physical activity is decreased during depression. Depression may be a main reason why obese persons are obese.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

93. TUOVINEN, T.; SOMPPI, E.; and HARTIALA, K. "Studien über die Reizbarkeit des m. gastrocnemius von Schwimmern, under besonderer Berucksichtigung eines Einflusses des Jahreszeit und der Individuellen Leistungsstufe." ("Studies on the Irritability of the Gastrocnemius of Swimmers, with Special Emphasis on the Influence of Seasonal Changes and Individual Performance") *Arbeitsphysiologie* 17: 419-28; March 1959.

The irritability of the Gastrocnemius muscle in eight swimmers was determined for seven months by measuring the electrical stimuli necessary for contraction. A seasonal change, due to the training condition, was shown. It could be said that, in general, the irritability of the muscle in good swimmers is higher than in bad swimmers. During a swimming period of one hour, the irritability decreased by an average of 39 percent, while this decrease was shown to be largest for those swimmers who had a tendency for muscle cramps.—*J. Royce.*

94. WAGLOW, I. F. "Nausea Resulting From Exercise." *The Physical Educator* 16: 23-24; March 1959.

Physical fitness tests including push-ups, sit-ups, and a 300-yard run were given to 2508 students. Three percent of those tested stated on a questionnaire given after the test that they had become nauseated or ill in some way from participating in the test. A large percentage of these students also reported on the questionnaire that they had either eaten just prior to the test or had not eaten 16 hours or more before the test. Others who were ill reported insufficient food ingestion during the day of the test and/or insufficient sleep. The study concluded that it appeared that the above factors contributed to the illness as well as the physical activity of the test itself.—*Hollis F. Fait.*

95. WALTERS, C. ETTA. "Scientific Foundations of the Overload Principle." *Scholastic Coach* 27: 20; April 1958.

Scientific principles underlying the overload principle with their applications to the learning of a motor skill are discussed.—*C. Etta Walters.*

96. WEISSLER, ARNOLD, M.; MCCRAW, BURLEY H.; and WARREN, JAMES V. "Pulmonary Blood Volume Determined by a Radioactive Tracer Technique." *Journal of Applied Physiology* 14: 531–34; July 1959.

A recently-developed collimated adapter was used to assay blood contained within the lungs of hospitalized patients without cardiovascular disease, ages 20 to 40. Studies were performed during quiet respiration following a ten to fifteen-minute rest period. The apparatus consisted of a shielded gamma-sensitive scintillation detector with a 2 x 2 inch sodium iodide crystal and a high voltage binary scaling unit. The pulmonary blood volume was calculated from the cardiac output and the average circulation time as determined by the dye dilution technique. On all occasions the dye was injected through a cardiac catheter into the superior vena cava.

The effects of the upright posture, peripheral venous pooling, and the Valsalva maneuver were studied. A fall in estimated pulmonary blood volume was discovered with each procedure, averaging 28 percent, 9 percent, and 11 percent below control levels, respectively. The greater fall in estimated pulmonary volume in the upright subject, when compared to the effect of venous occlusive cuffs in recumbency, suggests that the dimunition of pulmonary blood volume in the upright posture results from additional pooling in vascular areas outside the extremities.—*Carl S. Blyth.*

97. WHITACRE, JESSE, and GRIMES, ETHEL T. "Some Body Measurements of Native-Born White Children of Seven to Fourteen Years in Different Climatic Regions of Texas." *Child Development* 30: 177-209; June 1959.

Body size of approximately 6500 boys and girls were studied in relation to place of residence and occupational classification of their parents. Means of stature, hip girth, bitrochanteric diameter, and weight, all ages together, were significantly larger (at .01 level) for both boys and girls in the professional, semiprofessional, and business groups than those in the skilled and common labor groups whose means resembled each other.

When age was disregarded and the children were classified by hip girth intervals within stature intervals, place differences disappeared in the means of boys and girls alike for weight, bitrochanteric diameter, chest girth, calf girth, and waist height. Heights and weights for age groups plotted on the Wetzel grid showed that children in all places were of medium build, those above eight years being slightly the more slender. In size for age, the age groups placed close to the schedule of standard development (67th percentile) except that the 7- to 12-year-old groups in Houston were nearer the 15th percentile than the 67th. Age groups for girls were usually more than twelve developmental levels apart, year to year, from nine to twelve years, and likewise for boys from ten to twelve, and again thirteen to fourteen years. As possible factors to explain place differences in mean measurements, influence of children's age, possible difference in food consumption, possible difference in genetic background and in socioeconomic levels seemed to be ruled out.—*D. B. Van Dalen.*

98. Whyte, H. M. "Blood Pressure and Obesity." *Circulation* 19: 511; April 1959.

High correlations were found to exist between blood pressure and body weight with age having no influence. When allowances were made for age, fatness, height, and arm size there was still a significant relationship. Weight itself exerted the greatest influence on blood pressure with the weight relative to height the important factor. The best index of body bulk was found to be weight.

There was an insignificant relationship between fat and blood pressure except as fat influenced over all bulk. The systolic pressure rose by 10mm. Hg. and the diastolic by 7mm. Hg. for each increment of 28 pounds body weight. Serum cholesterol concentration was found to be related to age but not to weight or obesity.—*E. D. Michael.*

99. Wyndham, C. H., and others. "Methods of Cooling Subjects with Hyperpyrexia." *Journal of Applied Physiology* 14: 771-76; September 1959.

Six volunteers working in a climatic room raised their rectal temperature to 104 deg. F. by stepping on and off a stool one foot in height at a rate of 24 steps/min. This exercise was continued in the climatic room, set at a dry-bulb temperature of 97 deg. F. wet-bulb temperature 93 deg. F., (about 85% relative humidity-air flow at 120 ft./min.), until a rectal temperature of 104 deg. F. was reached or until the subject was incapacitated by impending heat collapse. A rectal temperature of 104 deg. F. was usually reached after 40 to 50 minutes of continuous work. Mouth and rectal temperatures were recorded simultaneously before, after 30 minutes, and at the end of the work period. Thereafter, they were recorded every five minutes of the 60-minute recovery period allowed for each of the seven cooling methods. The differences between the rate of cooling of individuals were not significant but the differences between methods were very significant (F=15.46 which is significant at the 5/10,000 level). The cooling rates of the six subjects under different conditions of cooling were used to calculate the time it would take an average individual to cool from 106 deg. F. to 101 deg. F. rectal temperature. The cooling methods used in this study are presented in the order of their effectiveness as follows (time required to cool the body to 101 deg. F. in parenthesis):

1. Sitting at rest at 90 deg. F. (D.B.), 87 deg. F. (W.B.), 120 ft./min. air flow, with flowing compressed air over the body and continuous wetting of the body surface with 87 deg. F. water. (48 minutes)
2. The second method was the same as above without compressed air. (50 minutes)
3. Sitting at rest at 70 deg. F. (D.B.), 20 percent relative humidity and still air. (56 minutes)
4. Three minutes of wetting the body surface with 87 deg. F. water, followed by sitting at rest at 90 deg. F. (D.B.), 87 deg. F. (W.B.), 120 ft./min. air flow. (66 minutes)
5. Immersion to the neck in cold water at 58 deg. F. (76 minutes)
6. Sitting at rest at 90 deg. F. (D.B.), 87 deg. F. (W.B.), 120 ft./min. air flow. (78 minutes)

7. Sitting at rest at 97 deg. F. (D.B.), 93 deg. F. (W.B.), 120 ft./min. air flow. (143 minutes)

These studies indicate that a subject with a temperature of 106 deg. F., and without any infective process, can be cooled in about an hour to a safe level, say 101 deg. F.—*Carl S. Blyth* and *Bill W. Lovingood.*

100. YOUNG, D. R.; MOSHER, R.; ERVE, P.; and SPECTOR, H. "Energy Metabolism and Gas Exchange during Treadmill Running in the Dog." *Journal of Applied Physiology* 14: 834; September 1959, and "Body Temperature and Heat Exchange during Treadmill Running in Dogs." *Journal of Applied Physiology* 14: 839; September 1959.

These two papers are part of a continuing series dedicated to the over-all goal of establishing nutritional requirements for situations in which hard physical work must be performed. In order to delineate areas of fruitful investigation for man, the dog was selected as the first experimental animal. A trained dog can easily be worked to exhaustion with endurance type exercise and the dog's metabolism and temperature regulation are "somewhat" similar to those of man.

The first paper describes the grade-running treadmill work test to which the dogs were routinely exposed. Data on oxygen requirement for running, maximum oxygen intake, oxygen debt, and respiratory efficiency are presented for 6 dogs. The maximum oxygen intake increased from age 21 weeks to 49 weeks. Total running time in minutes could not be predicted from the maximal oxygen intake (in 4 dogs), although the maximal oxygen intake remained a reliable characteristic of each animl. It was pointed out that oxygen debt is not a valid indication of caloric expenditure in the dog, perhaps because the work involved in panting obscures a "true" oxygen debt.

The second paper depicts problems in temperature regulation encountered by the dog during heavy exercise. An excellent correlation coefficient of +0.991 was found between the rate of rise of rectal temperature and maximum performance time. Ability to regulate body temperature was therefore of prime importance in maintaining a sustained work effort. It may well be postulated that in the dog as in man at high body temperature a disproportionately large fraction of cardiac output is diverted to the skin; thus, blood flow to the brain and working muscle is effectively reduced resulting in decreased work capacity and ultimately cessation of work.—*E. R. Buskirk.*

101. ZINOVIEFF, A. "Redevelopment of Muscle Power and Volume." *Journal of the Society of Remedial Gymnasts*, 16–18; 1959.

Although a number of different techniques of weight training have been described in the literature, little is known of their comparative values. It was the purpose of this study to compare the effects of three different techniques: (1) heavy resistance-low repetition; (2) medium resistance-medium repetition; and (3) low resistance-high repetition in the production of power and hypertrophy in the quadriceps of a consecutive series of patients at the Durham Miner's Rehabilitation Centre. A satisfactory increase in power was achieved with each of the three techniques in over 80 percent of the cases, and there appeared to be nothing to choose between them as a method of developing muscle power in traumatic cases. The low resistance-high repetition method proved best for building muscle volume.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

102. ZORBAUGH, HARVEY, editor. "Television in America's Schools." *Journal of Educational Sociology* 32: 413–60; May 1959.

This topic is the theme of the entire issue and five authors contributed articles, as follows: "The Expanding Role of Television in American Education," "Effective TV Production—'It's as Simple as Being Subjective,'" "The Changing Status of Educational Television," "The Program of the New York Regents," and "Prevalent Interests and Concerns in the Field of Televised Instruction." This issue will be a useful reference for anyone concerned with educational television.—*Bruce L. Bennett.*

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All AAHPER members who have been paid-up members for five consecutive years at the time of application may request a Fellow Application Form from the national headquarters office. (Years of membership as an undergraduate student do not apply.) The application form requests both detailed information about professional service and three endorsements. Members' credentials, as presented on the completed application form, are carefully reviewed. The cost of this membership is $15.00.

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